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ELECTRICAL TESTING INSTRUMENTS.

WE do not think we shall be mistaken if we say that no two men have done more towards simplifying electrical testing than Professors Ayrton and Perry. They have designed many forms of instruments for enabling practical electricians to take measurements which may, at least, be called approximately correct if not absolutely accurate, and they are never weary of striving to improve the construction, and to eliminate sources of error in their now well-known apparatus. Many men would have rested content with an original form of instrument, but it is not so with these gentlemen.

The paper which we published last week on direct-reading electrical measuring instruments is really a valuable contribution to our information on the subject of practical electrical testing, and certainly the value now to be attached to the voltmeters, ampèremeters, &c., of Messrs. Ayrton and Perry will be much enhanced. Everybody will appreciate the advantage of employing an instrument, on the scale of which the electromotive force or current may be read at a glance, and, on the other hand, all who have been in the habit of using apparatus in which a "calibration constant" was necessary, will readily acknowledge the objections thereto. The thanks of all electrical engineers are, in no small measure, due to the indefatigable exertions of the two Professors in the removal of the disadvantages of the earlier form of instrument and the substitution of the direct-reading type.

The ohmmeter designed by these gentlemen for reading off at once, by means of a pointer, the resistance of a circuit in ohms, should also prove an exceedingly valuable addition to electrical testing instruments. A Wheatstone "bridge" is not only very expensive, but it requires skill on the part of the manipulator who proposes to employ it. Chances of error are here introduced by a careless computation of the resistances unplugged and in several other ways, but in a direct-reading instrument, assuming it to be correctly adjusted, an error should be impossible. We would suggest, whilst commenting on the subject of resistance measurement, that Professors Ayrton and Perry should, to complete their apparatus, devise an instrument for reading off directly the insulation resistance of an electric light circuit. We are afraid that this is a measurement but rarely taken, but its importance can scarcely be overrated. Indeed, we could point to several cases of failure of the electric light which were entirely due to the omission of this test, and, therefore, on the part of the contractors, to a total ignorance of the state of the insulation of the conductors.

We believe that Messrs. Ayrton and Perry have further ensured the accuracy of their volt and ampèremeters by a still more recent form in which they employ a new spring and reject the permanent magnet altogether.

GAS ENGINES.

A MOST interesting report on some experiments with an "Otto" gas engine appears in *Van Nostrand's Engineering Magazine* for the present month. The tests were carried out last year by Messrs. Morgan Brooks and J. E. Steward, of the Stevens Institute of Technology, U.S.A.

They appear to be so thoroughly exhaustive, and to embody so careful an examination, both theoretical and experimental, that we would recommend their perusal by manufacturers of gas engines of all types. The authors speak favourably of these engines, especially for intermittent work, and Professor Robert Thurston, in some introductory remarks on the report to which we allude, says most emphatically that could the loss by the water jackets of gas engines (twice as much gas being demanded in even good machines having these water jackets as thermo-dynamic calculation would indicate) be by any means evaded, the gas engine would at once assume a vastly more important position as a prime motor than it now occupies. In one case Professor Thurston found that if the total heat supplied by the combustion of the gas is represented by 100, the distribution of the heat of combustion was as follows:—Useful dynamometric work 14·27, work of the pump 0·42, friction of mechanism 4·10, lost in exhaust 23·55, in water jacket 46·90, radiation, &c., 10·76. It may be that the experiments of Messrs. Brooks and Steward will point to a direction in which improvements may be effected in the gas engine. Even now it has found innumerable applications, for electric lighting specially so, and its advantages for many other purposes cannot be gainsaid. If it can be made more economical by improvements in design and construction, its field of operation will be indefinitely widened.

As the figures arrived at by the above-named gentlemen may be of interest to our readers, some of the more important will be found in our other columns.

EXPERIMENTAL RESEARCHES ON THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY.

By WARREN DE LA RUE, M.A., D.C.L., Ph.D., F.R.S., and HUGO W. MÜLLER, Ph.D., F.R.S.

SECOND POSTSCRIPT TO PART IV. "PHIL. TRANS.," PART II., VOL. 174.

Striking Distance.

IN a postscript to Part IV. of our researches* we stated that with 14,400 cells, partly of the rod form, partly of the chloride-in-powder form, the length of the spark

* *Phil. Trans.*, Part II., vol. 174, p. 725, separate copy p. 249.

between paraboloidal points was 0·7 inch (17·8 millims.), and between a point and disc 0·62 inch (15·7 millims.), and that it does not appear, therefore, that the law of the spark being as the square of the number of cells holds good beyond a certain number.

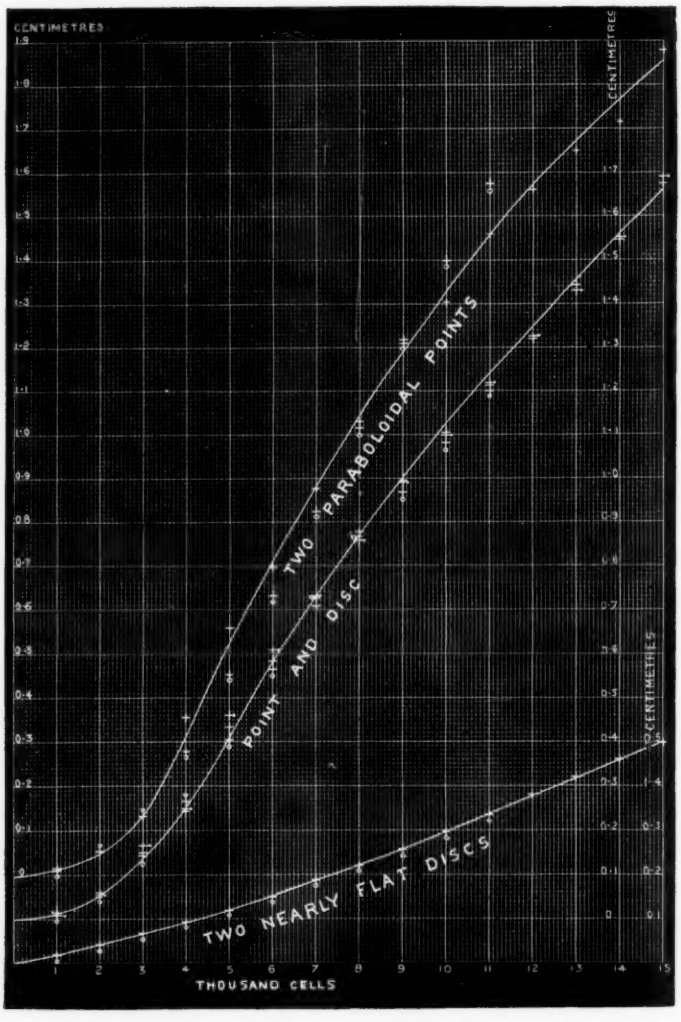
These results were obtained at the Royal Institution; since the removal of the battery to our laboratory we had not, at the date of the postscript to Part IV. of our researches, charged up the whole of it. Recently, however, we have put the battery in thorough order, by scraping the zinc rods* of the cells already charged up and added newly made up cells to bring up the total to 15,000 cells, all of the rod form.

Part I. of our researches,* and thus to restore it to a true paraboloidal form.

The following results were obtained between:—

TABLE I.—TWO DISCS.

Cells.	Striking Distance. Inch.	Striking Distance. Centim.
12,000	0·148	0·3759
13,000	0·160	0·4191
14,000	0·181	0·4597
15,000	0·198	0·5029



Having the whole 15,000 cells in perfect order we thought that it would be desirable to make fresh determinations of the striking distance, increasing the potential a thousand cells at a time, between two very slightly convex discs (planes), a point and disc, and two paraboloidal points. These points are one-eighth of an inch (3·175 millims.) in diameter, and three-eighths of an inch (9·525 millims.) long. In the case of a point and disc the point was like one of those used for two points, and the disc was $1\frac{5}{16}$ inch (3·334 centims.) in diameter. The two planes used were $1\frac{5}{16}$ inch (3·334 centims.) in diameter.

As the points, particularly the negative, are deformed at each discharge, the precaution was taken to touch up the point after each discharge in the shaping-tool, screwed to the mandril of the lathe, mentioned in

TABLE II.—A POINT AND A DISC.

Cells.	Striking Distance. Inch.	Striking Distance. Centim.
1,000	0·0055	0·0140
2,000	0·0240	0·0610
3,000	0·0600	0·1524
4,000	0·0950	0·2413
5,000	0·1700	0·4318
6,000	0·2300	0·5842
7,000	0·2770	0·7039
8,000	0·3450	0·8762
9,000	0·3900	0·9906
10,000	0·4340	1·1023
11,000	0·4780	1·2141
12,000	0·5200	1·3208
13,000	0·5680	1·4427
14,000	0·6090	1·5468
15,000	0·6580	1·6713

* We are at present making experiments in order to prevent the deposit of oxychloride of zinc on the zinc rods by covering the charging fluid with a layer of paraffin oil.

* *Phil. Trans.*, Part I., vol. 169, p. 79, separate copy p. 25.

TABLE III.—TWO POINTS.

Cells.	Striking distance. Inch.	Striking distance. Centim.
1,000	0·007	0·0178
2,000	0·020	0·0508
3,000	0·052	0·1320
4,000	0·140	0·3555
5,000	0·220	0·5588
6,000	0·273	0·6934
7,000	0·345	0·8762
8,000	0·405	1·0290
9,000	0·480	1·2192
10,000	0·513	1·3030
11.000	0·575	1·4605
12,000	0·614	1·5595
13,000	0·649	1·6490
14,000	0·675	1·7144
15,000	0·740	1·8800

These several results, the different sets being distinguished by plain crosses or crosses with a dot, are laid down on the diagram, fig. 1, to which are also added other results, already published, from former experiments; these latter have a ring on one of the members of the cross. The crosses for two discs, up to 11,000 inclusive, are taken from the table in Part III. of our researches,* those for the point and disc from Table XI. in Part I., p. 84, and the table in the same part, p. 116; those for two points, from Table XIII*a*, Curve XV*a*, p. 86, separate copy p. 32, and the table, p. 118, separate copy p. 64, of Part I. of our researches.†

TABLE IV.—TWO DISCS.

E.M.F. in volts.	Striking distance in centimetres.	Difference of potential per centimetre. Volts.	Intensity of force. Electro-magnetic.	Intensity of force. Electro-static.
1,000	0·0205	48,770	$4·88 \times 10^{12}$	163
2,000	0·0430	46,500	4·65 „	155
3,000	0·0660	45,450	4·55 „	152
4,000	0·0914	43,770	4·38 „	146
5,000	0·1176	42,510	4·25 „	142
6,000	0·1473	40,740	4·07 „	136
7,000	0·1800	38,890	3·89 „	130
8,000	0·2146	37,280	3·73 „	124
9,000	0·2495	36,070	3·61 „	120
10,000	0·2863	34,920	3·49 „	116
11,000	0·3245	33,900	3·39 „	113
12,000	0·3566	33,652	3·37 „	112
13,000	0·4068	31,957	3·20 „	107
14,000	0·4463	31,369	3·14 „	105
15,000	0·4882	30,725	3·07 „	102
15,450	0·5029	30,722	3·07 „	102

TABLE V.—A PARABOLOIDAL POINT AND A DISC.

E.M.F. in volts.	Striking distance in centimetres.	Difference of potential per centimetre. Volts.	Intensity of force. Electro-magnetic.	Intensity of force. Electro-static.
1,000	0·0123	81,103	$8·11 \times 10^{12}$	270
2,000	0·0567	35,274	3·53 „	118
3,000	0·1379	21,755	2·18 „	73
4,000	0·2447	16,347	1·63 „	54
5,000	0·4029	12,410	1·24 „	41
6,000	0·5631	10,655	1·07 „	36
7,000	0·7039	9,945	0·99 „	33
8,000	0·8447	9,471	0·95 „	32
9,000	0·9709	9,270	0·93 „	31
10,000	1·0874	9,196	0·92 „	31
11,000	1·1990	9,174	0·92 „	31
12,000	1·3058	9,190	0·92 „	31
13,000	1·4078	9,234	0·92 „	31
14,000	1·5145	9,244	0·92 „	31
15,000	1·6116	9,307	0·93 „	31
15,450	1·6600	9,307	0·93 „	31

* *Phil. Trans.*, Part I., vol. 171, p. 241, separate copy p. 177.
† *Phil. Trans.*, Part I., vol. 169, separate copy p. 64.

Through the absolute observations, curves were drawn as on the diagram to represent the mean of the experiments in Tables I., II., and III., represented on the diagram by plain crosses (without a ring). From these curves were deduced the numbers given in Tables IV., V., and VI., in C.G.S. units.

TABLE VI.—TWO PARABOLOIDAL POINTS.

E.M.F. in volts.	Striking distance in centimetres.	Difference of potential per centimetre. Volts.	Intensity of force. Electro-magnetic.	Intensity of force. Electro-static.
1,000	0·0173	57,866	$5·79 \times 10^{12}$	193
2,000	0·0493	40,568	4·06 „	135
3,000	0·1282	23,409	2·34 „	78
4,000	0·3078	12,996	1·30 „	43
5,000	0·5107	9,790	0·98 „	33
6,000	0·6845	8,766	0·88 „	29
7,000	0·8496	8,239	0·82 „	27
8,000	1·0117	7,908	0·79 „	26
9,000	1·1602	7,757	0·78 „	26
10,000	1·2913	7,744	0·77 „	26
11,000	1·3130	7,785	0·78 „	26
12,000	1·5243	7,873	0·79 „	26
13,000	1·6271	7,990	0·80 „	27
14,000	1·7146	8,165	0·82 „	27
15,000	1·7961	8,351	0·84 „	28
15,450	1·8500	8,351	0·84 „	28

An inspection of the diagram, drawn on a reduced scale from the curves as originally laid down, shows that the curve for approximate planes (slightly convex, to ensure the centres being the most prominent) is continuously concave, whereas those for both point and disc and two points are concave only for a certain distance, and then turn off and become convex. Moreover, that the intensity of force per centimetre decreases continuously up to 15,450 volts in the case of planes; but that, in the case of a point and disc, and also in that of two points, the decrease ceases after a certain potential has been reached, and that then it increases so as to become nearly a constant quantity. Between a point and a disc the potential per centimetre at 9,000 volts and beyond is very nearly 9,200; consequently, if the law holds good, to produce a spark 1 décimetre (3·94 inches) long, 92,000 volts, one 1 metre (39·37 inches) long, 920,000 volts,* and a flash of lightning 1 kilometre (0·621 mile) in length, a potential of 920,000,000 volts would be required, but this potential would be lessened by the diminution of the atmospheric pressure at the height of a kilometre, namely, 607·4 millims. (799,210 M), or a mean pressure of 713·8 millims. (939,211 M) between one kilometre and the earth. Taking the mean pressure 939,211 M, it would require 864,000,000 volts to produce a discharge between a cloud (regarded as a point) 1 kilometre high and the earth.

It is extremely difficult to conjecture how a cloud can become charged to such an enormous potential, unless the charged molecules balance each other (as those of a stratum in a vacuum tube may be conceived to do) until a disturbing cause breaks up the arrangement; and then the whole of them are discharged in one direction with their aggregate potential.

We may add that less than 15,000 cells would not have sufficed to make out the fact that the intensity of force to produce a discharge between a point and a disc or two points becomes a constant after 9,000 to 11,000 cells has been reached.

The following table gives the ratios of the striking distances between a point and a disc and two points respectively, taking those between two discs as unity. And also the relation between the striking distances

* To produce a spark between a point and a disc used for example as the discharges of an induction coil—

In length.	It would require in E.M.F. Volts.
1 inch	23,367
1 foot	280,400
1 yard	841,230

between a point and a disc and between two points, taking those between a point and a disc as unity :—

Cells.	Ratio between point and disc to that between two discs.	Ratio between two points and that between two discs.	Ratio between two points and that between a point and disc.
With 1,000	0·60	0·84	1·40
„ 2,000	1·32	1·15	0·87
„ 3,000	2·09	1·94	0·93
„ 4,000	2·68	3·37	1·26
„ 5,000	3·42	4·34	1·27
„ 6,000	3·82	4·65	1·22
„ 7,000	3·91	4·72	1·21
„ 8,000	3·94	4·71	1·20
„ 9,000	3·89	4·65	1·20
„ 10,000	3·89	4·51	1·19
„ 11,000	3·69	4·35	1·18
„ 12,000	3·58	4·18	1·17
„ 13,000	3·46	4·00	1·16
„ 14,000	3·39	3·84	1·13
„ 15,000	3·30	3·68	1·12
			Mean 1·16

The striking distances from which the above ratios are calculated are those obtained from the smoothed curves.

EXPERIMENTS WITH AN "OTTO" GAS ENGINE.

WE have, in our leading columns, referred to some tests made on an "Otto" gas engine, at the Stevens Institute of Technology, and we reproduce below a few of the principal points, from the report by Messrs. Brooks & Steward. The dimensions of the engine are given as follows :—

Stroke	14	in.	(356 mm.)
Diameter of piston	8·5	„	(216 „)
„ „ piston rod	1·75	„	(44 „)
„ „ connecting rod (crank end)	2·5	„	(63 „)
„ „ „ „ (piston end)	2·25	„	(57 „)
„ „ crank shaft	4	„	(102 „)
„ „ fly-wheels	66	„	(1680 „)
„ „ brake pulley	30	„	(762 „)
Length of brake arm	16·5	„	(420 „)
Weight of both fly-wheels	1650	lbs.	(750 kilos)

Clearance (compression chamber) 38 per cent. total cylinder volume.

A sixty-light dry meter was used, connected directly with the street gas main, to measure the gas used by the engine, exclusive of the igniting flames.

The supply of air was also measured, and the water required for the water jacket was measured by a Crown water meter placed near the gas meter, and its temperature, both before entering and immediately after leaving the water jacket, was measured by a standard thermometer.

The meters used were tested just before they were put in place, and an allowance has been made for the readings of the air meter, the only one appreciably inaccurate.

A Bulkley pyrometer was placed in the exhaust pipe as near as possible to the engine, giving the temperature of the discharged gases.

For the purpose of measuring the useful work of the engine a Prony brake, consisting of two iron hoops with blocks of wood fastened at short intervals, was clamped around a thirty-inch pulley on the crank shaft of the engine. A strut transmitted the pressure derived from the brake directly to a Fairbanks platform scale. This brake worked very smoothly without use of water.

The indicator used was of the Tabor pattern. It was placed directly upon the cover of the exhaust passage, and motion was taken from the cross-head by means of a cord running about a stepped pulley to reduce the stroke.

To measure the speed of the engine a speed counter was attached to the link moving the slide valve, thus recording the number of double revolutions.

All results have been reduced by the authors to horse-power, as being the most convenient form for ready comparison. The "horse-power in gas burned" was calculated from the analysis of Hoboken gas, and is the dynamic equivalent of the heat capacity of the gas. The "horse-power lost by exhaust" and "by water jacket" were calculated from the specific heats of the discharged gases and of water. The indicated horse-power was computed in the ordinary way from the number of explosions and the mean effective pressure. An allowance was made for the area between the exhaust and admission lines, representing work done in expelling the burned gases, and in drawing in the fresh charge. This allowance is equivalent to a little more than one-tenth of an atmosphere mean effective pressure.

The figures given for gas consumed do not include the amount burned by the two igniting flames. An allowance of 7 cubic feet (200 litres) per hour will cover this.

The difference between the indicated and the actual work gives the amount of friction in the engine, and the average of all the tests at full power is 18·6 per cent. friction, a remarkably good result.

The consumption of gas per horse-power per hour is larger than that usually obtained for the "Otto" engine. This is due chiefly to the poor quality of the gas used. The calculation given further on shows that only 5,495 calories can be obtained from the combustion of 1 cubic meter. For average quality illuminating gas, 6,000 calories is usually taken as a fair figure. Consequently, with 8½ per cent. less gas of average quality an equal amount of heat would be obtained.

An allowance should also be made for the temperature of the gas. In these experiments the gas had a temperature of about 24° C. Now, in winter the temperature of the gas would be reduced nearly, or perhaps quite, to the freezing point as it passed through the meter. It will be readily admitted that 5 per cent., or more, difference in the volume of gas consumed might easily result from the time of year at which the experiment was made.

It is safe to say that 21 cubic feet (600 litres) per hour of good quality illuminating gas at ordinary temperature is sufficient to develop one horse-power with the Otto engine. In fact, this result has frequently been obtained.

The ratio of air to gas was found, by actual measurement of both, to be about seven to one, when the engine was working most economically. Although with better gas the ratio would be slightly increased, yet it could not equal that usually given for the "Otto" engine—ten to one or thereabouts.

When the proportion of air is increased by partly closing the gas valve, the explosion line is much more inclined, the mean effective pressure is less, consequently also the indicated horse-power. The gas consumption per indicated horse-power is not much changed, but per effective horse-power it becomes considerably greater, showing the false economy of throttling the gas supply. A comparison of tests, in which the conditions other than the ratio of air to gas are nearly identical, shows very plainly the disadvantage of using too little gas.

From the tables it appears that the amount of heat carried off by the water jacket is about half of the total heat of combustion of the gas burned. When the cylinder is kept cool by a plentiful supply of water, the quantity of heat carried away appears to be greater than when less water is used, and the cylinder allowed to become warmer.

From this, one is led to expect a greater percentage of useful work with less water. But a careful comparison of the results fails to show that any marked difference in either the indicated or the actual work is caused by varying the temperature of the water jacket.

It is probable that much more heat is lost by direct radiation when the cylinder is warm than when it is cool, and that this accounts in part, at least, for the apparent difference in the quantity of heat carried away by the water jacket in the two cases.

The indicated work represents 18 per cent. of the total heat of combustion of the gas. The actual useful work is 14½ per cent.

An efficiency sometimes given for the gas engine, derived from the indicator diagram alone, is the indicated work divided by the indicated heat, giving about 30 per cent. This is manifestly incorrect, since the indicated heat is not the whole heat of the gas.

The best steam engines utilise only 10 per cent. of the total heat of combustion of the coal, and small engines rarely exceed 5 per cent., so that the gas engine is by far the more perfect heat engine.

Heat is disposed of in a gas engine in these ways :—

(1.) As indicated work, including useful work and friction.

(2.) In the hot expelled gases.

(3.) In the water jacket.

(4.) In radiation, &c.

Taking the figures directly from test 19, but making allowance for probable error in the figure for water jacket, it is found that

(1)	= 1·33 calories	or 17 per cent.
(2)	= 1·18 „	15½ „
(3)	= 4·00 „	52 „
(4)	= 1·18 „	15½ „

the sum 7·69 calories, being the total heat of combustion of the gas.

Relative Economy of Gas, Steam, and Hot-Air Engines.

In making a comparison of this kind it is necessary to consider,

(1.) The cost of gas or coal consumed.

(2.) The cost of water used.

(3.) Lubrication.

(4.) The cost of attendance.

(5.) Depreciation and repairs.

(6.) Interest on capital invested.

(1.) The average consumption of gas in a gas engine per effective horse-power per hour, including igniting flames, is about 30 cubic feet.

The consumption of coal per effective horse-power per hour by small steam engines is about 7 lbs.

(2.) The water used in the water jacket of a gas engine will not enter into the estimate, since by the use of tanks the same water may be used continuously.

The water supplied to the boiler of the steam-engine here considered amounts to $\frac{5}{6}$ths cubic foot per horse-power per hour.

(4.) A gas engine requires little or no attendance. A man can accomplish $\frac{1}{6}$ths of a day's work and still take full charge.

Steam engines of this size require from half to one day's attention, depending upon the proximity of the engine and boiler.

(5.) As regards depreciation, it is safe to say that gas and steam engines have about equal terms of life ; for, while gas engines have less complication of working parts than steam engines, yet they are subject to more severe and abrupt strains.

(6.) The interest will necessarily be directly proportional to the amount of capital invested.

The following summary shows the relative cost of a day's running :—

Gas Engine, 8 H.P. actual, 10 hours.

(1)	2,400 cubic feet gas @ $2·50 per 1,000	$6·00
(2)	Water	0·00
(3)	Lubrication	0·20
(4)	One-sixth day's labour @ $2·00	0·33
(5)	Depreciation, &c., at 12 per cent. per year $\frac{12}{100}$ per cent. on $1,075	0·36
(6)	Interest at 5 per cent. per year $\frac{5}{100}$ per cent. on $1,075	0·15
	Daily expense	$7·04

Steam Engine, 8 H.P. actual, 10 hours.

(1)	Coal $\frac{800}{2240}$ tons @ $5·00	$1·25
(2)	Feed water 65 cubic feet @ $1·25 per 1,000 ...	0·08
(3)	Lubrication	0·15
(4)	Half-day's labour at $2·00	1·00
(5)	Depreciation, &c., at 12 per cent. per year $\frac{12}{100}$ per cent. on $800	0·27
(6)	Interest @ 5 per cent. per year $\frac{5}{100}$ per cent. on $800	0·11
	Daily expense	$2·86

The following figures have been obtained for the expense of running a small hot-air engine. This engine has been running in a printing office in New York City for 18 years. It uses 4½ lbs. of coal per H.P. per hour ; every third year relining costs $100.

Hot-Air Engine, 2½ H.P. actual, 10 hours.

(1)	Coal $\frac{112·5}{2240}$ tons at $5	$0·25
(2)	Water	0·00
(3)	Lubrication	0·10
(4)	Attendance same as for gas engine	0·33
(5)	Depreciation, &c., @ 10 per cent. per year $\frac{10}{300}$ per cent. on $750	0·21
(6)	Interest @ 5 per cent. per year $\frac{5}{300}$ per cent. on $750	0·10
	Daily expense	$0·99

The cost of 1 horse-power per hour is,

With gas engine	8¾ cents.
With steam engine	3½ „
With hot-air engine	4 „

For intermittent work the gas engine is much more economical than the above figures indicate ; and this fact, together with its safety, cleanliness, and convenience, makes the gas engine very desirable where small powers are required.

With cheaper kinds of gas it becomes possible to reduce the figures for gas engines as low, if not lower, than those obtained for steam engines. In England and Germany, where the cost of illuminating gas varies from $0·50 to $0·75 per 1,000 cubic feet, the above figures would be reduced 60 per cent., making the daily expense of the gas engine about $2·75.

It should be remembered that *illuminating* gas is not required for the gas engine. The manufacture and distribution in cities of some cheap gas especially adapted for use in gas engines may soon become a prominent industry ; and, with economy added to its other merits, the gas engine may largely supplant steam for manufacturing and other purposes.

ON THE GALVANIC BEHAVIOUR OF THE AMALGAMS OF ZINC AND OF CADMIUM.

By W. L. ROBB.

According to the experiments of Poggendorff the amalgams of zinc, tin and lead, when plunged into dilute sulphuric acid, show an abnormal, *i.e.*, a positive behaviour with the same metals not amalgamated. On the other hand, the amalgams of iron and cadmium are negative to the same metals in a pure state. Subsequently Henrici made this reaction the subject of several experiments which, however, did not lead to a complete explanation of the phenomena. He succeeded by certain procedures in obtaining a normal current, *i.e.*, the amalgams under these conditions were found negative to the corresponding metals. He was therefore of the opinion that the cause of the anomaly was to be found in a secondary action, and that the amalgams of zinc, tin and lead, as well as those of iron and cadmium, rank below the corresponding metals in the series of galvanic tension.

As the above-mentioned researches were carried out at a time when galvanic movements were far from having reached their present accuracy it seemed requisite to submit the phenomenon to further investigation. The following experiments were conducted in the physical laboratory of Privy Councillor Von Helmholtz, and I must, by this opportunity, express my warmest and most sincere thanks for the kind assistance which he extended to me during the following investigations.

1. *The method of research.*

The earlier experiments were directed chiefly to a measurement of the strength of the currents which are obtained on plunging the metal and its amalgam into dilute acid. In order to arrive at an explanation of the phenomenon, it seemed more advisable to determine the electromotive forces, not only in acids, but in

solutions of the salts of the metal concerned. These were determined by means of Du Bois Reymond's modification of Poggendorff's compensation-method. As the forces were very small, a very sensitive galvanometer with a pair of astatic needles was used, in order to reach the required degree of accuracy. As a constant element, a Daniell of the form known in this laboratory as the "high Daniell," was employed. The element used in these experiments differs from that described by A. König, in the circumstance that for dilute sulphuric acid there is substituted a dilute solution of zinc sulphate, about 4 per cent. This element was found very constant and quite suitable for my purpose, both as regards the internal resistance and the electromotive force. In default of accurate and concordant determinations of the electromotive force of this element in absolute measurement, it is in the following experiments assumed to = 1.

2. *Experiments on zinc amalgam.*

As the anomaly appeared most strongly marked in the case of zinc this metal was first investigated. At the very outset two difficulties were encountered.

a. Equalisation of the zinc rods.—At first two pieces of the purest commercial zinc, cut from the same bar, were found unequal in their electric potential. This difference was found occasionally so great that two such zinc rods in a solution of zinc sulphate produced an electromotive force of some thousandths of that of a Daniell. As the differences to be measured between the metal and its amalgam are minute, it was necessary to equalise the two zinc rods before amalgamating one of them. I effected this at first by placing the two zinc rods to be adjusted in a solution of zinc sulphate, and connecting them together so as to form a closed circuit. After they had remained for several hours in this position they were approximately equalised. In the sequel I ceased to employ this method as it consumed too much time, and as, after the one rod was amalgamated, the surface of the other underwent a change, and I could not restore it to its original condition. Ultimately I equalised the zinc rods by coating them with zinc, precipitated galvanically. It need scarcely be said that, for this purpose, there was used a solution of the purest zinc sulphate. As soon as the surfaces were sufficiently coated the two zinc rods were found approximately equal in their galvanic behaviour. The greatest value of the electromotive force which I obtained from elements consisting of two such zinc rods immersed in zinc sulphate was only 0·00031 Daniell, and the average value, from six such determinations, was only 0·00017 D. Afterwards I employed a method, described below, for depositing the zinc uniformly, and used the precaution of neutralising the solution of zinc sulphate before using it for determinations of the electromotive force, the differences of the zinc rods then became much smaller, the value of the electromotive power not exceeding 0·00005 D. This method of equalising the zinc rods has the further advantage over that first described, that a zinc rod, after standing for a long time, and becoming oxidised on its surface, or otherwise impure, could be brought back to its former galvanic condition by cleansing with dilute acid. As an example, I mention a case where the electromotive force, produced by an amalgamated and an unamalgamated rod (both as clean as possible), in a concentrated solution of zinc sulphate was found = 0·00022 D. After this determination both were exposed for some days to the air, whereby their surface was oxidised and generally rendered impure. The value of the electromotive force was then found increased to 0·00041 D. But after the surface of both had been carefully cleaned with very weak acid and distilled water, it fell again to 0·00028 D.

b. Preparation of the zinc.—The second difficulty was to obtain zinc of a satisfactory purity. After the purest commercial zinc had remained for some time immersed in acid, its surface, even when the acid was very weak, became covered with a blackish grey substance, due to the impurities of the zinc, which, of course, had an influence upon the electromotive force. Several experiments, however, proved that this was not the case with zinc which had been deposited galvanically from the purest commercial zinc sulphate. At first I simply deposited the zinc upon rods of distilled zinc, but, as in several experiments, the rods had to be exposed for a considerable time to the action of acid, the galvanically-deposited coating was eaten away in parts, on account of the impossibility of precipitating it everywhere with absolute uniformity. At such places the disturbing influence of the impurities of the distilled zinc was then experienced. Ultimately I employed rods which consisted entirely of galvanically-deposited zinc. In order to obtain them, I made use of the following method, which was found the most suitable. As an electrolyte a solution of zinc sulphate was used. The positive electrode consisted of platinum, and the negative, upon which the zinc was to be deposited, of a piece of wax taper, about six centimetres in length, the surface of which was covered with fine copper dust. I twisted round the upper end of this a wire in connection with the negative pole of the battery, and thus the wax rod formed part of the circuit, the copper dust serving as conductor. In order to keep the zinc equally deposited, only the very finest copper dust could be used, and it was necessary to rub it with particular uniformity into the surface of the wax. In a few minutes after the circuit was established the surface of the wax rod was perfectly and uniformly coated. After a short use the solution of zinc sulphate contained so much free acid, liberated by electrolysis, that the zinc was deposited irregularly, and sometimes even as oxide. Hence it was necessary very frequently to substitute a fresh solution of zinc sulphate, or to prevent the development of the acid. The latter expedient being, of course, preferable, was attempted as follows :—

The vessel containing the solution of zinc sulphate was divided in two parts by means of a porous partition. As I had to be certain of the purity of this substance (which would not be the case with an earthen cell), I used filter paper, fixed to the bottom and sides of the vessel with paraffine. That part of the vessel containing the platinum electrode was filled with carbonate of zinc, which was obtained by adding a concentrated solution of zinc sulphate to a concentrated solution of bicarbonate of soda. Then a great part, if not all, the acid liberated at the positive electrode combined with the zinc of the carbonate of zinc to form sulphate of zinc, whilst the carbonic acid liberated was given off as gas. In this manner the solution could be used much longer than without such an arrangement to prevent the development of acid. After the zinc had been deposited upon the wax-rod in such a thickness that there was no fear of its breaking, it was taken out of the liquid, the wax was removed, and the zinc was then freed from the copper with which its inner surface was covered. This was effected by dipping a cord in acid, sprinkling it over with sand so as to produce a kind of file, and drawing it up and down through the channel left by the removal of the wax. Then a copper wire was soldered to one end of the zinc cylinder in order to introduce the zinc more easily into the circuit. The connecting wires were always soldered to the zinc, whatever its kind. Finally, when I felt certain that all the copper was removed, the hollow zinc cylinder was filled up with pure paraffine, and the precipitation of the zinc was then continued until a sufficient thickness was obtained. In general, this operation was continued until the outer coating had a thickness of two millimetres. If the zinc was eaten through by the acid in any part, it had no further influence upon the electromotive force, as the paraffine, thus laid bare, is a non-conductor. After what has been said, it need scarcely be mentioned that the several zinc rods thus obtained were sufficiently uniform in their galvanic constitution, so that any further equalisation was unnecessary.

c. On the electromotive force of galvanic elements of pure and amalgamated zinc in concentrated solutions of a salt of zinc.—In order to exclude every possibility of any influence of an inequality in the contact of the

metals with the air at the surface of the solution and to prevent the soldered connecting-wire from dipping, unperceived, into the liquid, the upper end of the zinc was enclosed in a glass tube with paraffine. The upper extremity of the zinc was then found to be about five millimetres below the surface of the liquid, so that a contact of the metals with the air was totally avoided. Before every definite determination, it was necessary to ascertain if any other electromotive force was present in the circuit. In the first place, the electromotive force was determined when both zinc rods were not amalgamated, so as to determine if they were sufficiently equal in their galvanic constitution. If this was the case, one of them was amalgamated with pure mercury and the electromotive force was again determined. The following values of the electromotive forces which were obtained by using solutions of the salts of the metals concerned, were not measured until they had become constant. As the metals, immediately before being placed in the liquid, were rinsed with distilled water, some time elapsed before the liquid became perfectly homogeneous. In general, the value became constant before the expiry of an hour. This value was sometimes greater, and sometimes smaller, as that which was found at once when the metals were introduced into the liquid. In the first determinations of this kind zinc rods were employed whose surface only consisted of galvanically deposited zinc. I also used solutions of the purest commercial sulphate and acetate of zinc, though without at first ascertaining whether they were neutral or not.

The following table shows the values which were thus ascertained. There was taken as null value the potential in that zinc rod which remained unamalgamated during the investigations; e_1 indicates the potential in the second zinc rod before amalgamation and e_2 after amalgamation; $e_2 - e_1$ indicates the increase of the electromotive force occasioned by the amalgamation of one zinc rod.

ZINC IN A CONCENTRATED SOLUTION OF ZINC SULPHATE.

e_1	e_2	$e_2 - e_1$
+ 0·00026 D.	+ 0·00080 D.	+ 0·00054 D.
+ 0·00015 „	+ 0·00090 „	+ 0·00075 „
+ 0·00001 „	+ 0·00095 „	+ 0·00094 „
− 0·00001 „	+ 0·00090 „	+ 0·00091 „
− 0·00031 „	+ 0·00035 „	+ 0·00066 „
+ 0·00029 „	+ 0·00140 „	+ 0·00111 „
	Mean value ...	+ 0·00082 D.

With the two latter zinc rods there were also measurements made with acetate of zinc in place of the sulphate, the results being—

$$e_1 = + 0{\cdot}00030 \text{ D}\,; \; e_2 = + 0{\cdot}00295 \text{ D}\,;$$
$$e_2 - e_1 = 0{\cdot}00265 \text{ D}.$$

The several values of $e_2 - e_1$ deviate certainly widely from the mean value, but if we consider that acid was present in the solutions and that only the exterior layer of the zinc rods had been equalised, nothing else could be expected. As a matter of course, and from the same causes, the values obtained with a solution of sulphate of zinc are not comparable with those obtained on using a solution of the acetate of zinc.

After I had used rods consisting entirely of zinc galvanically precipitated, but before I had begun to neutralise the saline solutions, I obtained the following values :—

ZINC IN A CONCENTRATED SOLUTION OF ZINC SULPHATE.

e_1	e_2	$e_2 - e_1$
− 0·00003 D	+ 0·00022 D	+ 0·00025 D.
+ 0·00005 „	+ 0·00056 „	+ 0·00051 „
− 0·00003 „	+ 0·00020 „	+ 0·00023 „
	Mean value ...	+ 0·00033 D.

Finally, when the solution was so far neutralised that no action could be perceived on the surface of the unamalgamated zinc until the electromotive force had become constant, I obtained the following values :—

ZINC IN A CONCENTRATED NEUTRALISED SOLUTION OF ZINC SULPHATE.

e_1	e_2	$e_2 - e_1$
− 0·000050 D.	− 0·000090 D.	− 0·000040 D.
+ 0·000015 „	+ 0·000290 „	+ 0·000275 „
+ 0·000010 „	+ 0·000155 „	+ 0·000145 „
+ 0·000010 „	− 0·000105 „	− 0·000115 „
	Mean value ...	+ 0·000065 D.

ZINC IN A CONCENTRATED NEUTRALISED SOLUTION OF ZINC ACETATE.

e_1	e_2	$e_2 - e_1$
+ 0·000085 D.	+ 0·000370 D.	+ 0·000285 D.
+ 0·000010 „	− 0·000155 „	− 0·000165 „
+ 0·000010 „	− 0·000240 „	− 0·000250 „
	Mean value ...	− 0·000045 D.

From the above value we may be justified in concluding that amalgamated zinc and pure zinc are so nearly alike in their galvanic behaviour that their potential difference in a concentrated solution of a zinc salt, not neutralised, is equal only to a few thousandths of the potential difference of a Daniell, and that, when the solution is sufficiently neutralised not to exert any action upon non-amalgamed zinc, it is quite evanescent.

Of course, from these determinations nothing can be inferred as to the relative position of amalgamated and non-amalgamated zinc in the series of galvanic tensions.

(To be continued.)

A WEIGHT VOLTAMETER.

[A COMMUNICATION.]

WHILE experimenting with apparatus for the measurement of electric currents, the idea of doing so by means of a weight voltameter suggested itself as being a method which, at all events, would have the advantage of being constant, and unaffected by external agents, as temperature, pressure, magnetism, &c.

The following is a brief description of one of the forms which I constructed and experimented with.

DESCRIPTION.

It consists, as will be seen from the drawing, of a glass tube, A, provided with two arms, B, B, containing the platinum wires, which are welded to and support the electrodes, C, C. The bulb, D, is filled conveniently with pieces of thin glass tube; these serve to keep sprays of water from being mechanically carried over into the drying tube, E, containing chloride of calcium.

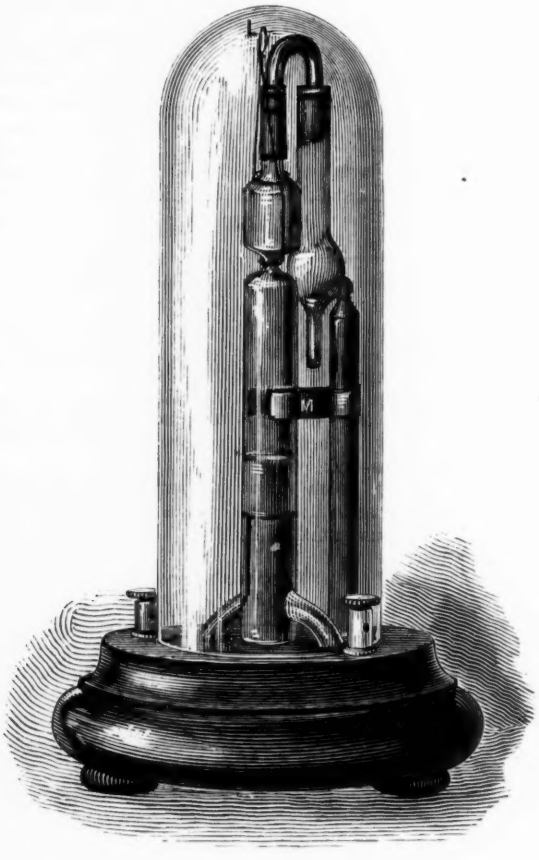
The stand has three circular cavities, *f*, G, and H. G holds the bottom of the voltameter, and *f*, H accommodate its arms, B, B; *f* and H contain mercury, and are connected by copper wires to the binding screws, *i*, *i*. They are fitted on the top with round pieces of sheet rubber, which are fastened to, and kept in their places by, small portable wooden rings, K, K. These rubbers, being slit nearly across, form valves, which permit the apparatus being shifted about without loss of mercury, at the same time freely admitting the arms, B, B.

These mercury cups form a cool and reliable con-

nection, and to a great extent do away with the inconveniences and risks tending the direct connecting of the terminals with the platinum wires, such as the heating of the junctions and the cracking of that part of the glass into which the wires supporting the electrodes are fused. N, N represents a glass shade

TAKING A MEASUREMENT.

The terminals of the wires through which the current to be measured flows are fixed in the binding screws, *i*, *i*, and the voltameter freed from air by allowing the electrolysis to proceed for a minute or so, it is now suspended from a balance by the wire, L, weighed and placed in the spring clip, M. At a given time the circuit is completed by quickly pressing the arms, B, B, into the mercury cups, *f* and H, the electrolysis is continued for some minutes, when, at a noted time, the circuit is broken by slightly raising the voltameter



in the clip, M. It is again weighed, and the difference gives the exact quantity of water electrolysed.

Now, by referring to the known fact that "the amount of water electrolysed in a given time is exactly in proportion to the current strength, and a unit current decomposes ·0000945 of a gramme of water in one second." The current strength then in ampères is obtained by dividing the weight of water electrolysed, by the constant ·0000945, multiplied by the time taken reduced to seconds, thus :—

$$C \times t \times \cdot0000945 = \text{Wt. of water decomposed};$$

$$\therefore C = \frac{\text{Wt. of water decomposed}}{\cdot0000945 \times t}.$$

Let W_1 = original weight of voltameter in grammes ; let W_2 = weight after passage of current ; let T = time in seconds ; let C = current in ampères.

Then $W_1 - W_2$ = Wt. of water electrolysed.

$$C = \frac{W_1 - W_2}{\cdot0000945 \times T}.$$

Example :—

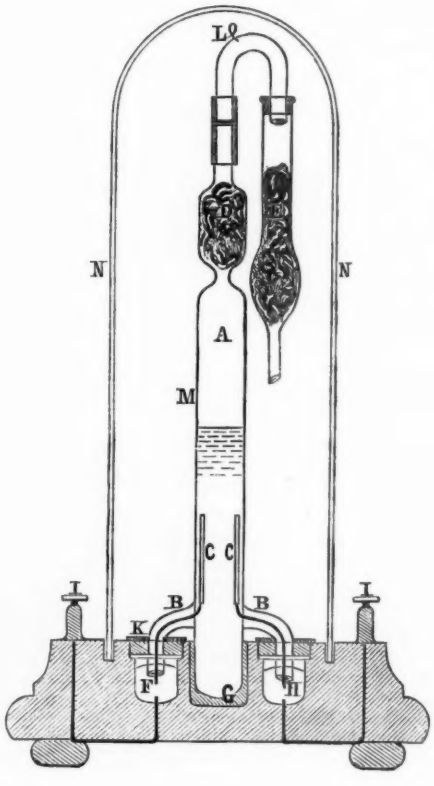
$W_1 = 52{\cdot}3215$ grams ; $W_2 = 52{\cdot}2199$ grams ; T = 600 seconds.

$$\therefore C = \frac{52{\cdot}3215 - 52{\cdot}2199}{\cdot0000945 \times 600.} = 1{\cdot}791 \text{ ampères.}$$

NOTE.—This form of weight voltameter is not adapted for the measurement of very strong currents, but rather for laboratory and experimental work, where accuracy and constancy are of first importance. When the water (acidulated with sulphuric acid) requires renewing, the apparatus is held by A in the warm hand, by which means some of the gases or air will be expelled. If now a little water, free from acid, be dropped into D it will, on removal of the hand, be sucked into A.

LAURENCE N. LEDINGHAM.

Govan, *Feb. 16th*, 1884.



DANIEL DRAWBAUGH.

IT is probable that many of our readers have mentally formed some conception of the personal appearance of Daniel Drawbaugh, and we therefore think that a portrait of that now-celebrated man will not be without interest. We are enabled to give this week, through the courtesy of a friend, a reduced sketch of Mr. Drawbaugh from a photograph by Moreno.

It is believed that his first ideas on the electrical transmission of speech date back from 1860, or thereabouts. He was born, according to American information, where he has always lived and still lives—at Eberly's Mills, a little village of perhaps a score of houses, built in a sort of valley or ravine, some four miles distant by a bad road from Harrisburg, Pa. Drawbaugh himself was always one of those odd geniuses, frequently to be found in country communities, who can do almost anything in the mechanical line and do it well. He repaired the clocks and the guns, painted the waggons and the portraits, built the furniture and the machinery of his neighbours with equal facility.

This was his trade—he bore the title of a machinist by way of courtesy. His hobby and delight was electrical apparatus, and while he painted waggons and fixed clocks to accommodate the needs of his neighbours and the necessities of his rather large family, he made, until he become solely immersed in the telephone, electric clocks and batteries, and dial telegraphs and electric bells, and a host of other electrical contrivances, all excellent of their kind and always successful in operation. This was his work. Some of his inventions, a nail-making machine among others, were patented, and he had begun to gather some small returns from them; but when the war broke out it found all the money owing him in the hands of Southern debtors, and they retaliated on the emancipation proclamation by confiscating it. If he had smothered his inventive tendency and worked his ten hours a day in some of the Harrisburg machine shops he might have just kept clear of debt; but the condition was to him impossible, so he compromised with fate by doing the odd jobs as they came along, and consoling himself for hard fortune in the invention and improvement of the telephone.

DANIEL DRAWBAUGH.

Since 1876 Mr. Drawbaugh has been constantly engaged in inventing and perfecting new telephones. The transmitting apparatus, which embodies all the essential features of the transmitter in common use, was followed by another instrument of more special construction, containing double carbons and double induction coils. This was succeeded by another apparatus containing, in exceedingly compact form, both a carbon transmitter and a receiver, so arranged that while a person talks into the transmitting portion, the receiving part of the instrument can be conveniently held to the ear. Since 1879 Mr. Drawbaugh has obtained a large number of patents for various improved instruments—nearly twenty—and applications for patents for as many more are under consideration in the United States Patent Office.

Among the new telephones which have been patented to him is a receiver which reproduces speech with ample loudness to be heard throughout a moderate-sized room; also several ingenious forms of transmitters in which the carbons are held in contact by gravity, and without springs or other adjusting devices. Mr. Drawbaugh is still at work in his laboratory at Eberly's Mills, and within the last three months has produced no less than six novel telephones. The records of the Patent Office since 1879 show that no inventor has been more prolific than he in this field of invention.

The remarkable facts which we published last week, with illustrations of Drawbaugh's early apparatus, have doubtless made him the centre of interest in the telephonic world.

Th. Du MONCEL.

IT is with much regret that we have to announce the death of this very eminent man of science, which took place at his residence in Paris, on Monday, the 18th inst. Few have enjoyed a more extended, we may say universal, reputation as an electrician than the deceased gentleman, one or more of whose works have certainly been consulted by everyone who has in any way occupied himself in electrical matters.

The son of a General of the Engineers, Monsieur du Moncel was born in 1821. He manifested from his youth a decided taste for drawing, archæology, and natural science. He was scarcely eighteen years of age, when, on leaving the Collége de Caen, where he had been a student, he published a *Traité de Perspective Mathematique*, which was soon followed by a *Traité de Perspective Apparente*. These works showed that the young author was both a mathematician and an artist. A relative of M. de Caumont, the well-known archæologist, the young Comte du Moncel was introduced by him to the study of archæology. He undertook long journeys to the south and east of Europe, from whence he brought back numerous documents, which he published in 1847, under the title: "*De Venise à Constantinople à travers la Grèce.*" M. Th. du Moncel belonged to that branch of the French nobility which considers that modern society will be elevated by profound studies. Unfortunately, he did not obtain from his family the necessary encouragement and support. He soon abandoned archæology and art publications to devote himself entirely to science, and especially to electricity.

In 1852, he commenced, in the *Journal de l'arron-*

dissement de Valognes, to describe the recent discoveries in electricity. These articles were the origin of M. du Moncel's publications devoted to the popularisation of the great discoveries of this century. After *l'Exposé des Applications de l'Electricité*, which appeared in a series of five volumes, M. du Moncel followed it by a number of volumes: *Le Téléphone, l'Eclairage Electrique, le Microphone et le Phonographe, l'Electricité comme force Motrice*, works of which the reprinting and numerous translations prove the value.

The labours of M. du Moncel in physics are too numerous for us to be able to quote them in detail. From 1850 to 1856 he introduced more than twenty-five new apparatus, amongst which we may point out: *l'Anèmographe Electrique, le Mesureur électrique à distance des niveaux d'eau, l'Enregistreur electrique des improvisations musicales, l'Eclaireur electrique des cavités obscures du corps humain*, &c., as well as several special systems of telegraphy, a registering galvanometer, a receiver for submarine lines, spherometers, &c.

The most important scientific discoveries of Comte du Moncel relate to induced currents, batteries, and electro-magnets. After having studied and established the principle of the double composition of the induction spark, he was the first to ascertain the characteristics of the two coils which compose it. He discovered the effects of distributed and condensed magnetism, he established the best mode of construction for electro-magnets, and his researches upon the conductivity of semi-conductors gave to science accurate data upon the electrical resistance of wood, minerals, earth and tissues.

In 1860 M. du Moncel was appointed Ingenieur Electricien de l'Administration des lignes télégraphiques, and only left this occupation in 1874 to join the Academie des Sciences, where he had the good fortune to present at public meetings the discoveries of the telephone, the microphone, the radiophone, and the phonograph.

In 1866 Comte du Moncel was made Officier de la Legion d'Honneur.

On the appearance of *La Lumière Electrique*, in 1879, he undertook the scientific editorship, and readers know with what activity, care and competence he fulfilled this task.

The moral qualities of M. du Moncel, his aimiability, and his benevolence made him beloved by all who knew him, and his death, as well as being a loss to science, will also be most deeply regretted by his friends. We are indebted to the courtesy of Dr. Cornelius Herz for the brief particulars here enumerated.

NOTES.

Electric Lighting.—Beyond supplying the requirements of the new 1,000-light station at Boston of the American Electric and Illuminating Co., the Thomson-Houston Co. has just shipped a hundred more lights to St. Louis. Additions have also been recently made to the plant at Worcester, and further demands come from Portland and Lewiston, Me., and Lowell, Mass.; while New Haven has a new plant of 100 lights.

Supt. S. A. Duncan, of the Brush Co., at Pittsburgh, Pa., operated recently fifty-eight standard Brush lamps (2,000 candle power), on a nineteen-mile circuit, using a No. 8 Brush dynamo, having the new armature. The circuit is of No. 6 wire.

Mr. Geo. Bower, writing from St. Neots to the *Times*, says:—"I have read Mr. Coope's letter in the *Times* of Jan. 29 with much interest, as he gives what appears to be a fair and honest statement of the cost of lighting his house by electricity. Perhaps you will kindly allow me to give details of the cost of lighting the same number of burners with gas, for the same number of hours and of equal illuminating power, if Mr. Coope made the gas himself. My qualification for this duty rests on the fact that I have for the past 30 years been extensively engaged in the erection of gas works in every quarter of the globe, where the gas has had to be made from almost every liquid and solid capable of yielding flame when burnt in the open air. Mr. Coope has 200 lights, and they were used for an average of 1,823 hours during the past year. The first cost of the manufacturing plant and of the installation was £1,490 8s., and the net cost of the year's lighting £359 18s. 9d. To supply the 200 lights with gas for 1,823 hours would require 1,458,400 cubic feet of gas, made from coal, with a proportion of Cannel so as to give the requisite illuminating power. The first cost of the works, including the necessary buildings and the interior fittings, would be between £900 and £1,000. The cost of producing the gas would be as follows:—150 tons of coal, with a proportion of Cannel, at 24s. per ton, £180; purification of the gas, £10; labour, £52; wear and tear of manufacturing plant, £30; depreciation of plant 5 per cent. on £400, and on buildings 3 per cent. on £300, £29; total gross cost, £301. But there would be 50 tons of coke to spare at 18s. per ton, £45, and other residuals £10, £55, leaving as the net cost of the gas to supply 200 lights, burning on an average 1,823 hours per year, £246, or nearly 3s. 5d. per 1,000 cubic feet, being less than one-sixth of a penny per light per hour, electricity costing just 50 per cent. more. If Mr. Coope had taken interest on capital into consideration at £5 per cent., there would have been about £75 to add on electric lighting outlay, and only £50 on the gas works capital. Mr. Coope admits that he has had several stoppages, and they might have happened at a very inconvenient time. The only remedy for this would be the adoption of accumulators at a further considerable outlay. In gas works the gasholder is the accumulator. If gas be properly consumed the cost of the light may be much reduced. Lamps are now constructed so that they will give fully double the light for the same quantity of gas used as the best London Argands, while the products of combustion converging in a central tube can be conveyed out of the room at pleasure; but as the products arising from perfectly consumed gas are only carbonic acid gas and water, they are as innocuous as are the products from wax candles or from oil. In the Aquarium at Brighton there are some of these improved gas lights burning, giving a much better light than more than three times the quantity of gas burnt under the best ordinary conditions. The fact is, that electricity has done much good to the gas manufacturer, for it has shown that something more is required of him than simply to manufacture gas and say, 'There it is; take it or leave it, as you please.' He finds that he must show the customer how best to burn it so as to get the greatest effect at the least cost, for in that lies his safety. This duty is only just beginning to be understood, so that what with improvements in the manufacture and in the consumption of gas, electricity, except for special purposes, will not yet awhile encroach much on the gas manufacturers' domain."

The Administration of the Assistance Publique has decided to introduce experimentally the use of Edison incandescent lights in the halls inhabited by patients in the Hotel Dieu, which is the largest and the leading French hospital.

A paper was read on the evening of the 18th inst., at the ordinary meeting of the Royal Institute of British Architects, on the "Electric Lighting of Houses and the precautions to be adopted on its introduction," by Mr. Killingworth Hedges, C.E. The steady increase of electric lighting for house purposes was shown by the number of installations which have recently been made by the occupants of houses both in town and country. In large cities a temporary check had been experienced with the general supply of electricity as contemplated by the Act of 1882. The electrical currents which would be employed for lighting a dwelling are very powerful, and without some precautions were taken to insure their being properly

regulated, they might cause great risk from fire. Mr. Hedges pointed out how this risk might be occasioned, and suggested that the rules of the Fire Risk Committee should be strictly adhered to, especially those which advised that all work should be under the supervision of a competent electrician. Many fires had been caused by the electric light, which is used largely in America for mill lighting, the official report showing that all these were either due to neglect of precautions for safety or by not having the work properly supervised. As regards cost, the fixed charges with electric lighting, such as supervision, interest, &c., caused it to be much dearer than gas when used for a short period; but if these charges were spread over a number of hours, electricity was relatively much cheaper. Mr. Hedges recommended the introduction of the electric light on account of the ultimate saving in the renewal of decorations and preservation of works of art. The property of not vitiating the air should, alone, make electricity rank, independent of its cost, as one of the greatest sanitary improvements of the age. The paper was followed by a discussion.

The special correspondent of the *Standard*, writing from the *Euryalus*, off Suakim, on Sunday, says:—"I must again remark that it is scandalous that ships of war on the Indian station are not fitted with the electric light. Had the vessels now here possessed this apparatus an attack would be impossible. It is unfortunate that the French ships have not arrived. They would certainly have electric lights, for the French men-of-war are always well supplied with modern scientific apparatus, while the apathy of our own naval authorities as to such matters is lamentable."

The electric light has been used in connection with the rebuilding of the extensive seed-crushing mills of Messrs. J. and F. Badart Frères, Rotherhithe. Mr. E. A. Gruning, the architect of the Royal Hotel, was entrusted with the superintendence of the new work. The smaller mill was actually completed, and the heavy machinery, including two stone revolving-wheels of eight tons each, were fitted in 103 working days. No. 1 mill, which is the largest of the kind in Europe, extensive warehouses of five floors for the reception and storage of the raw materials, a shaft 120 feet high, offices and foremen's dwellings are all in a state of completion, and the machinery in the large mill will soon be in working order. These extensive operations could only have been carried out through the winter in so short a space of time by the aid of the electric light, which enabled the men to work day and night without the slightest inconvenience. The work was commenced by the aid of a No. 1 Gülcher dynamo, and four arc lamps, the dynamo being afterwards replaced by a No. 4, capable of driving 32 arc lamps. The number of lamps actually in use, varied from six to 25, according to the requirements of the time. As the buildings progressed the lights were raised and kept about 10 feet or 15 feet above the work. The lamps were 500 candle-power—the most suitable, it is said, where a light is required to be spread over a large area, and shadows have to be avoided. The whole installation was supplied by the Gülcher Electric Light and Power Company, Limited, and was under the superintendence of Mr. Joseph Crookes. The interesting work of seed crushing and oil refining is now being carried on by aid of the electric light, and even the barges on the river are unloaded at night by means of an arc light suspended from the roof. The offices and private dwelling-house are being fitted up with Crookes' incandescent lamps, which admirably answers the purpose. The erection and design of the buildings and machinery have been under the special direction of Mr. George Badart, the contractors being Messrs. Holland and Hannen, and Messrs. Clarke and Bracey, and the engineers, Messrs. Davey, Paxman & Co., Messrs. Galloway and Sons, and Messrs. Fraser and Fraser, makers of the boilers and engines.

On the evening of the 15th inst., the members of the Leeds Association of Foremen Engineers and Draughtsmen, to the number of about 100, visited the works of the Leeds Forge Company, Limited, at Armley. Mr. Samson Fox, C.E., the managing director, and Mr. W. Fox acted as guides to the visitors, and fully explained each process, sparing no pains to make the visit a pleasant one. The company assembled in the testing-house, a building in which all the materials are subjected to the mechanical test of pulling asunder, which proves their tensile strength and ductility. In one case the specimen was exhibited of an old-fashioned flue which had stood a test equal to a strain of 225 lb. to the square inch, whilst alongside it was a flue of exactly the same proportions but which was corrugated. It had stood a test equal to 1,020 lb. to the square inch. In the flanging shop the electric light was seen in operation. Here, also, the interesting operation of welding plates for large marine boilers to steel tubes by a mixture of gas and atmospheric air was witnessed; passing thence to Fox's Patent Corrugating Mill, the company was able to see the process which has made the Leeds Forge so famous. The tube having been heated for about seven minutes in a large furnace, it is passed to the mill on a special carriage and run to the corrugating rolls, which are worked by engines of 1,500 horse-power, made by Messrs. Tannett, Walker, & Co., Leeds, who are also the builders of the Corrugating Mill. The process of corrugating the tube only occupies two minutes, and it is then passed on to the flanging shop to be flanged. The electric light, which attracted a great deal of attention, has been laid down under the superintendence of Mr. Wilson Hartnell, of Leeds, and is supplied by Crompton & Co., Chelmsford. The whole area of the shed—about 1½ acres—is lighted with this light, which has proved a great success, in fact, the managing director stated that, owing to the manner in which the light had been spread, this mode of illumination cost less money, all things considered, than Leeds gas at the present time.

An installation was inaugurated last Monday which although not one of the largest in the metropolis, is yet certainly one of the most important. The Bank of England is a bye-word for safety and caution, and it is certain that within its walls no haphazard or speculative experiments would be permitted. Some of the directors considered that the health of the large staff should always be one of their first subjects of consideration, and they therefore determined, if possible, to adopt electrical illumination. During the latter part of 1882, and the whole of last year, the accumulator has been employed in installations varying greatly in character, but sufficient evidence was afforded to the directors of the Bank of England to justify them in entrusting the first installation of electric light to be effected in the Bank to the Electrical Power Storage Company, Limited. The work has necessarily been slow in consequence of the very limited periods during which workmen could be employed. The motive power was intended to be taken from the existing steam engine and boiler (manufactured by Messrs. Boulton, Watt & Co., over forty years ago) during those hours when the power was not otherwise required; but it was subsequently found to be more convenient temporarily to put down a horizontal portable engine and boiler specially to drive the dynamo machine. This is one of the "Victoria" type, constructed by the Anglo-American Brush Electric Light Corporation, and its E. M. F. is 120 volts. The dynamo charges an accumulator of fifty-five Faure-Sellon-Volckmar cells, which, in turn, feed 150 incandescent lamps. The lamps are distributed throughout the private drawing office, the bill office, and the vaults. These latter, in which are deposited the boxes with the customers' securities, have thirty-two lamps, each of 20 C.P., and the officials observed, even upon the first day's employment of the light, the comparative purity of the atmosphere as compared with the gas lighting. The installation is fitted throughout with the Andersen patent magnetic safety cut-out, which is regulated so as to automatically break the

circuit when a certain fixed current is exceeded. This instrument possesses the great advantage that it can be thoroughly tested and certified before it is employed. High tension Swan lamps are at present employed, and the fittings have been manufactured specially by the Electrical Power Storage Company, Limited, and are attached to each gas standard in such a manner as to permit the use of either electricity or gas, or both, at any moment without interfering with the other. The whole of the installation has been carried out under the personal supervision of Mr. F. Thornton, the Works manager of the Company, and when inspected on Monday last by the deputy-governor and several of his colleagues it met with unanimous approval and commendation.

We are informed that the Crystal Palace lighting will be undertaken by the Gülcher Electric Light Company, with seventy-five arc lamps. The price to be paid per annum is, we understand, considerably lower than many well-informed engineers consider a remunerative one. We have, indeed, heard the amount is only £500 per year, but we cannot vouch for its accuracy.

Some very interesting electric lighting experiments, says the *Times* of the 21st inst., are about to be made in Wimbledon to determine the best mode of lighting public streets. They will be conducted by Mr. Preece, F.R.S., and are intended to determine the relative efficiency of arc and incandescent lighting, the proper distribution of lamps, and the most effective and economical way of diffusing light. The engine and dynamo are in position. The experiments are independent of any system or interests, and are looked forward to with much scientific as well as public interest.

The *Crocodile*, which will leave Portsmouth on the 24th with military drafts for Malta and Bombay, has made a satisfactory trial of her electrical system of lighting. The lamps used are Edison's incandescent, of which there are on board 98 of 16-candle power, 288 of 10 candle-power, and two yard-arm lights, each of 50 candle-power. The dynamos are of the Edison-Hopkinson type, and are driven by two Brotherhood engines of the new type recently mentioned by us. The installation was carried out for the Edison and Swan United Companies, by whom the remaining troopships will be fitted, by Mr. D. C. Bute. The plant is in duplicate, and the whole installation has been completed in less than a month.

Telephony.—The leading Lisbon newspaper, *As Instituicoes*, of the 14th inst., has the following editorial paragraph on the favourable progress of the Edison-Gower-Bell Telephone Company of Europe in Lisbon and Portugal:—"The Edison Telephone Company in Lisbon are extending their exchange lines to Sacaveno and Povea de Santa Iria. The work is progressing with extraordinary rapidity, under the able direction of Mr. Alfred Thompson, the intelligent engineer of the company, to whose high competency and great activity is to be attributed the augmented receipts, now not small, of the company."

Messrs. Johnson and Phillips, telegraph engineers and contractors, announce that their City offices, 14, Union Court, Old Broad Street, are now in direct telephonic communication by private wire with their works at Charlton, as well as in connection with the Central Exchange.

The Conservators of the River Thames have presented a petition against the United Telephone Company's bill. At a recent meeting of the Shoreditch Vestry a committee, to whom the question was relegated, reported in favour of opposing the same Bill.

Lancashire and Cheshire Telephone Exchange Company, Limited.—The employés of this company held a *soirée* in Manchester on Saturday evening last, when contingents arrived from Liverpool and North Lancashire districts to meet the headquarters staff in Manchester; the total number present being about two hundred. In the lecture hall of the Athenæum, a few words of advice and encouragment were spoken by the chairman of the company, Mr. Charles Moseley, and then a programme, consisting of songs, instrumental music, and dancing was gone through, all present appearing to thoroughly enjoy themselves. In the ante room of the Athenæum a number of telephones were connected with the Royal and Prince's theatres, and afforded much amusement to those who desired to listen to the performance of the pantomimes. The chief officials of the company were present, including Mr. Kenneth MacIver, secretary and general manager; Mr. T. S. Clark, engineer; Mr. R. H. Claxton, manager, Liverpool district; Mr. J. A. Chambers, manager, North Lancashire district; Mr. J. Poole and Mr. J. H. Haworth, electricians. Though this telephone company has only been established some four and a-half years, its operations are on a very large scale, and embrace the whole of Lancashire, Cheshire, and North Wales. A fair idea of the high value placed by the public on the telephone, as an immensely useful help in conducting business at our modern high-pressure speed, may be gathered from the fact that in addition to the two hundred present at the *soirée*, and which chiefly consisted of members of the indoor staff, the company employs about 150 persons on the *out-door* service of constructing and repairing telephone lines. The success attending the first *soirée* has been so gratifying that, we are given to understand, it has been decided to make the occurrence a yearly one.

Society of Telegraph Engineers and Electricians.—At the meeting of this Society, to be held on the 28th inst., the following papers will be read:—"On some prejudicial action in dynamo-machines," by Mr. B. W. M. Mordey, associate; and "On the effects of induction in alternate current machines," by Professor George Forbes, member.

Berly's Universal Electrical Directory.—We have received a copy of the third edition of this work, which contains not only all the good features of the last edition, but which has had a great deal of thought bestowed on the re-arrangement of the parts, so that they may be more readily found. They consist of British, American, and Continental sections, in the first of which sections the country and London names are combined (a great improvement on the divided method of last year), and the Continental section is subdivided into French, German, and other countries. There are in each case both classified trades and alphabetical directories. As the edges of the book are distinctly coloured, and the names of the sections printed in bold letters thereon, it is far easier to find the information sought than in the earlier issues of this work, and in addition to this an attempt has been made to eliminate the names of those firms and individuals only indirectly associated with electrical matters. Notwithstanding the remarks in the preface, we notice at a glance several inaccuracies and omissions, which, we think, should by careful editorial management be avoided. It is to be hoped that, now the form in which it will each year be produced has been settled, the corrections will be more carefully attended to; the book will then have additional value from the reliability of its contents. The British section, we may mention, is also to be obtained by itself at half the price of the complete work.

The Cambrian Fine Art Exhibition, Cardiff.—This Exhibition, which opened on 14th inst., is lit by arc and incandescent lamps fixed by the Great Western Electric Light and Power Company, the current being supplied from the company's lighting station in Working Street. There are 56 incandescent lamps attached to handsome electroliers and brackets, placed at carefully determined distances throughout the halls, and eight arc lamps suspended from the ceilings and the walls. The effective arrangement of the incandescent lamps is greatly admired, and the arc lamps are burning with a steadiness and an absence of "hissing," which seldom distinguish any arc lamp. This result is

the more satisfactory, as the Brush machines supplying the current are working the two town circuits, which have not shown the slightest consequential variation. On these circuits are arc and incandescent lamps, at the Theatre Royal, the *South Wales Daily News* office, the Philharmonic Music Hall, many of the more important business establishments, and the Circus. The company is about extending its circuit so as to supply the Great Western Coffee Tavern, and other public and private establishments. The whole of the installation has been carried out by the superintendent of the lighting station, Mr. Benjamin Deakin.

Mudford's Improvements in Mirror Galvanometers.—In December, 1882, we described and illustrated Mudford's arrangement of the Thomson mirror galvanometer. This device appears to have pleased Sir William Thomson, for he writes to Mr. Mudford as follows :—"I think you have made a decided improvement on my astatic mirror galvanometer in attaching the mirror to the bar connecting the two needles, instead of attaching it to one of the needles, as I have done hitherto ; and in modifying the form of the coils as you have done, to take advantage of the space thus left free round one of the needles."

Telegraphic Competition.—A trial of skill in telegraphy for a silver cup offered by the proprietors of the *Telegraphist*, occasioned much interest at the West London Schools of Telegraphy and Electrical Engineering, 101, Uxbridge Road, on Friday and Saturday last week. The competition was open to all telegraphists, postal, cable, and railway, and a small entrance fee was charged, the amount thus collected being divided between the first, second, and third best and quickest senders on the Morse key. There were 40 entries, of whom two were ladies. Some of the competitors were from the provinces, but the majority were those engaged in Fleet Street newspaper offices and the Stock Exchange. The judges, who were previously selected by a committee of the competitors, were Mr. W. Webb and Mr. W. Miell, of the Central Telegraph Office, the umpire being Mr. W. T. Douglas, who was sent by Mr. Fischer, the Controller of Telegraphs. Mr. A. Graves, of the engineering department of the Postal Telegraphs, took charge of the apparatus and looked after its working. There were two sending instruments, a double current and a single current Morse key, the competitors taking their choice of either. These instruments were placed in an upper room at the School of Telegraphy, while the recording instrument, which was a Wheatstone automatic receiver, was placed in a lower apartment where were the judges and the umpire. The subject for competitive transmission was a portion of the Queen's Speech, consisting of 250 words, and each competitor had to send this message, the two main elements of success being the time occupied in transmission, and the correctness of the delivery. The contest was concluded on Saturday night. The judges retired at about 11.30 p.m., and in less than five minutes they unanimously declared Mr. J. Chapman, of the Stock Exchange, London, as the champion Morse manipulator for 1884; Mr. J. Dennett, of the Central Telegraph Office, London, second; and Mr. A. Brooker, of the Central Telegraph Office, London, third. The competition proved that the highest speed attainable for really good sending does not exceed 35 words a minute. The result of the contest was received with great satisfaction by the competitors and visitors. Mr. Chapman was formerly in the employ of the South-Western Railway Company, and entered the Postal Telegraph service some years back. He is a scientific telegraphist, having devoted his leisure time to the study of the laws of electricity, and his mechanical contrivances have already brought him under the notice of the heads of the department. It is intended to renew the competition annually.

A New Firm.—Mr. Holroyd Smith, of Halifax, and Mr. C. Baker, recently with Messrs. Blakey, Emmott & Co., have commenced business as telegraph engineers and electricians at Cornbrook Telegraph Works, Manchester. Mr. Smith is already well known in connection with electrical tramways, and at the last meeting of the British Association he read a paper on that subject.

Phosphor-Bronze Company, Limited.—At the meeting of this company, held on the 8th inst., Mr. R. Lagerwall was appointed manager, in addition to his office as secretary.

Release of Mr. Dale.—Mr. Higgins, Q.C., and Mr. Farwell applied on Friday, the 15th inst., to Mr. Justice Pearson, for the discharge from custody of Mr. Henry James Dale, who was committed to Holloway Prison on the 15th of January, for contempt of court in having manufactured and sold certain instruments which had been made in accordance with the manner described in the plaintiffs' letters patent of July, 1877, in direct disobedience of an order the court. The prisoner had entered into an engagement with the plaintiffs with which they were satisfied, and they would no longer oppose his being discharged.—Mr. Cozens Hardy, Q.C., and Mr. Moulton appeared for the United Telephone Company.—Mr. Justice Pearson said that the prisoner had already suffered a severe penalty in being kept for so long a time from the superintendence of his business. His Lordship did not desire that he should be any longer kept in prison, and he would make an order for his discharge, and he must pay all the costs.

Errata.—In the letter signed "E." on the efficiency of the Heinrichs dynamo, which appeared last week, for $\frac{R}{+r}$ in last column of second table read $\frac{R}{R+r}$. For "mutually distinctive of each other," in last paragraph but one, read *mutually destructive of each other*.

The Cable Steamer "Faraday."—Lloyd's agent at Portland telegraphed at 10.40 a.m. on Thursday :—"The *Faraday*, cable steamer, has put back to Weymouth with port propeller gone, and it is proposed that a powerful tug should accompany her back to London. The *Faraday* broke down in the Atlantic on Feb. 10th, and was compelled to put back for repairs."

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

West Middlesex Electric Lighting Company, Limited.—The return of this company, made up to the 14th ult., was filed on the 14th inst. The nominal capital is £100,000 in £5 shares ; 220 shares have been issued, and of these 167 are fully paid up. Upon the remaining 53 shares nothing has, as yet, been called. Registered office : Caxton House, The Grove, Hammersmith.

CITY NOTES, REPORTS, MEETINGS, &c.

Jablochkoff Electric Light and Power Company, Limited.

An extraordinary general meeting of the shareholders of this company was held at the offices, 1, Great Winchester Street Buildings, on Wednesday, for the purpose of confirming special resolutions unanimously passed at a meeting held on the 1st inst. Mr. James Wilson presided ; the attendance of shareholders was small.

Mr. F. R. Reeves (secretary and general manager) having read the notice convening the meeting,

The Chairman moved that the resolutions "that this company be wound up voluntarily," and "that William Augustine Spain, of 76, Coleman Street, London, chartered accountant, be and is hereby appointed liquidator of the company," be confirmed, which resolutions were seconded by Mr. Rodwell and Mr. Marten respectively, and carried with but one dissentient.

The Chairman then moved the following :—"That a general authority be and is hereby conferred on the said liquidator to transfer the business and property of this company to a proposed new company when incorporated, and to be named the Jablochkoff

and General Electric Company, Limited, or such other name as shall be decided upon, and to receive in compensation for such transfer shares or other like interests in the said company, as contemplated by the 161st section of the Companies' Act, 1862. And for that purpose, to enter into an agreement with the said new company for the sale to that company of this company's business and property upon the terms of the draft agreement in that behalf submitted to the meeting." That resolution, he reminded them, was passed unanimously at the previous meeting, and the scheme, the details of which had been published, as he had before told them, was the best the directors could do for them. Several public prints had asked, "Why should they, the old company, get £55,000 for what they were going to hand over to the new company?" The answer was that they gave the new company a going business, several lighting stations, several contracts, their stock-in-trade, and, in fact, everything that was necessary to carry on the business which they had placed on a good and firm footing. They were giving something substantial, but the surprise was that they should get so much for it. He might mention that since the last meeting a circular had come into his hands which had been issued to the shareholders by M. Gaudet, who said that when the Chairman stated that the resolutions in question were passed unanimously the directors had before them a written protest, delivered by himself, as the representative of shareholders holding more than half of the entire capital of the company, whose opinion it was that the terms offered were not the best that could be obtained, as negociations were pending which would enable a much more favourable arrangement to be made than that which was before the meeting. The Chairman remarked that the protest alluded to was a personal one, handed to him as he was proceeding to the table at the last meeting by M. Gaudet, whose statement that he represented shareholders to the extent of more than half the capital of the company was not correct. Moreover, M. Gaudet was at the meeting himself, the resolutions were unanimously passed, and he agreed to them, inasmuch as he did not vote against them. Now, perhaps, having the advice of some persons wishing to have a finger in the pie, he adopted his present course. He (the Chairman) could only say that the directors were the trustees of their property, and had done their best.

Mr. Lawrence seconded the resolution.

Mr. Percival Smith said he did not understand that the draft agreement was finally approved at the last meeting.

The Chairman remarked that those were only the terms upon which they hoped to effect the disposal of the company; they were not positive about it. If impediments were thrown in their way, the directors did not think the interests of the shareholders would be best served. The opinions of the body of the shareholders were represented by the proxies in their favour which the directors had received.

The Solicitor of the company said he wished the shareholders to properly understand the position. The draft agreement read at the last meeting indicated what, in the judgment of the directors, would be a very good arrangement if they could succeed in carrying it out. They must understand that there was a provisional liquidator already appointed, who had possession, upon an order of the court, of all the assets and property of the company. Probably an order would be made on Saturday to wind up the company under the supervision of the Court of Chancery, and then it would be for the directors to negotiate with the liquidator for some such arrangement as that proposed, the general scope of which had been explained to the shareholders. He did not think that any business man would have a doubt that if the directors could succeed in forming a new company upon some such basis as that, it would be an extremely good thing. Failing that, the whole of their property would have to be sold, under the direction of the Court of Chancery, and they would receive what remained after the whole of the costs of litigation were paid. With the object of carrying out their scheme, if possible, the directors had recently given their best consideration to the matter, and some of them had foregone personal claims for the sake of enabling the official liquidator to keep the property together; had they not done so, almost a catastrophe would have occurred. Shareholders should understand that what they were asked to pass amounted to nothing more than a general authority to the directors to do the best they could in aiding the formation of a new company, to save their property from ruin.

M. Gaudet observed that a friend of his had been distinctly refused permission by Mr. Spain to look over the works.

The Solicitor said Mr. Spain was a most experienced man, and must have had good reason for what he did. He was appointed provisional liquidator by the Court, to which he was responsible for his actions. It was absolutely necessary to put him in possession, or the works would have been stopped, the men dispersed, and the loss to the shareholders would have been very great indeed; and now, unless they presented a united front, their property would be wasted.

Mr. Taylor remarked, with reference to the action which it seemed M. Gaudet desired to take, that he understood the power to act would, in the course of a few days, rest solely with the official liquidator, and the proposal before the meeting was simply in the form of an instruction to him as to the manner in which they wished him, if possible, to deal with the property they had to dispose of. Therefore, it was clear that the official liquidator was the person before whom M. Gaudet should place his proposal for the purchase of the company, when that gentleman would be able to consider whether it was better than the present scheme or not. He (Mr. Taylor) could not see that there was any warrant for M. Gaudet's interference to stop the passing of those resolutions, for their adoption would not in any way interfere with the consideration of his proposal. He hoped the official liquidator would exercise the fullest latitude in that regard; and he might say that there was one point in connection with the proposals regarding the value of which he was rather sceptical—that was, that the new company should give a certain number of debentures. He believed the suggestion originated with the official liquidator himself, but he did not see the value of it. If they sold at all it should be for money, and he should be sorry to see the new company launched with a debt on its back. If it were started with plenty of money, free of debt, and properly managed, with a due regard for economy, he had no doubt good results would follow.

The Chairman said the board considered the suggestion of Mr. Spain an excellent one to fall back upon if necessary, and they adopted it with very great respect.

The resolution was then put and carried, the only dissentient, as before, being M. Gaudet.

Captain Isaac moved a vote of thanks to the directors, in whom he expressed great confidence, and, having been seconded by Mr. Conder, the motion was carried, and suitably acknowledged by the Chairman.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.

THE following is the directors' report for the year ending December 31st, 1883, to be presented at the twentieth ordinary general meeting of the shareholders, to be held on Tuesday next:—The annexed accounts show the result of the company's business for the past year. The net profit amounts to £48,390 16s. Adding £36,311 7s. 3d. brought forward, and deducting £15,600 paid in July, there remains a disposable balance of £69,102 3s. 3d. The directors recommend the distribution of a dividend of £1 per share, amounting to £31,200, and making, with the interim dividend, a total payment for the year of 15 per cent., free of income tax, carrying forward £37,902 3s. 3d.

The death of Dr. Beattie early this year has deprived the directors of an old and esteemed colleague, whose loss they sincerely regret. The appointment of his successor rests with the directors under the articles of association; and they propose to fill the vacancy by the election of Mr. Abraham Scott, who has long been connected with the company, and is at present one of the auditors.

The general sales compare favourably with those for 1882; but in the first half of the year the cable department was short of work. Important contracts for cables between Spain, the Canary Islands, and Senegal were entered into under subventions from the French and Spanish Governments; but, as these are still in course of completion, no credit had been taken for any profit, and the work merely stands in the accounts at cost.

Less progress than the directors intended has been made with the Workmen's Hall; but the matter is not being neglected, though other building operations at Silvertown have interfered with it. The new works mentioned in the last report as being in progress at Silvertown and Persan-Beaumont are nearly completed; and the railway now runs into the factory yard at the latter place.

The company's bill in Parliament referred to in the circular of the 12th of November, will be considered at an extraordinary general meeting, notice of which is given with this report.

Mr. Henderson, the director retiring by rotation, offers himself for re-election.

Balance-sheet, 31st December, 1883:—

Capital and Liabilities: To share capital—amount authorised to be raised, £812,000. To share capital—amount subscribed and paid on authorised issue of 31,200 shares of £10 each, £312,000; mortgage debentures, £100,000; reserve fund, £200,000; loans owing by the company, £79,320; sundry open accounts and acceptances, £115,853 1s. 11d.; suspense account, £14,381 10s. 3d.; proposed dividend, 10 per cent., £31,200; balance of profit and loss account, as below, £37,902 3s. 3d.—Total, £890,656 15s. 5d. *Assets and Expenditure:* By property, consisting of freehold land, buildings and machinery at Silvertown and at Persan-Beaumont, also steamships *Silvertown*, *Dacia*, and *International*, £437,190 8s. 5d.; debts owing to the company, £61,375 6s. 10d.; cash with bankers and in hand, £9,219 0s. 8d.; bills receivable, £205 11s. 8d.; stock-in-trade, taken at or under cost, including Senegal cable not yet shipped, £189,110 7s. 4d.; shares in other companies, £2,037 10s.; balance of Persan-Beaumont working and agency accounts, £86,682 12s. 1d.; expenditure on account of Cadiz-Canaries contract,* £104,835 18s. 5d.—Total, £890,656 15s. 5d. *Profit and Loss Account* for the year ending 31st December, 1883.—To salaries, interest, and general expenses, £51,648 6s. 2d.; bad debts, £1,039 14s. 5d.; income tax, £2,265 4s. 10d.; depreciation written off buildings and machinery, £12,542 7s.; directors' remuneration (minimum), £2,000; balance—profit for the year, carried down, £50,300 16s. 0d.—Total, £119,796 8s. 5d. By gross profit for the year, including profit on securities realised, £119,796 8s. 5d. To interim dividend of 5 per cent., paid 24th July, £15,600, proposed dividend of 10 per cent., £31,200—£46,800; balance to be carried forward to 1884, £37,902 3s. 3d.—Total, £84,702 3s. 3d. By balance brought down, £50,300 16s.;

* Against this are held debentures for £120,000 of the Spanish National Submarine Telegraph Company, Limited, secured upon a subvention from the Spanish Government, and to be issued so soon as that subvention becomes payable. Shares in that Company are also held against this item.

less additional remuneration due to the directors after payment of 10 per cent. to shareholders, £1,910—£48,390 16s. 0d.; balance of the year 1882, £36,311 7s. 3d.—Total, £84,702 3s. 3d.

Telegraph Construction and Maintenance Company, Limited.

THE report of the directors, to be submitted to the members, at the twentieth ordinary meeting, to be held on Tuesday next, is as under:—

The accounts for the year show a net profit of £93,334 16s. after charging the interest on the debentures. To this sum must be added £63,015 5s. 9d. brought forward from last year, making a total of £156,350 1s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 24th, 1883, amounting to £22,410, leaving £133,940 1s. 9d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, free of income tax, leaving £66,710 1s. 9d. to be carried forward to the next account.

The operations carried out during the year 1883 have been as follows:—

A cable, 965 miles in length (manufactured in 1882), was laid early in the year between Hong Kong and Shanghai for the Eastern Extension Telegraph Company.

A cable, 1,402 miles in length (a large portion of which was manufactured in 1882), has been laid in the Red Sea, between Suez and Aden, for the Eastern Telegraph Company, and was completed in the month of April.

Cables of the total length of 1,369 miles have been manufactured and laid for the Great Northern Telegraph Company of Copenhagen, between Shanghai, in China, and Nagasaki, in Japan, and between the latter port and the Russian Settlement of Vladivostock. These lines were completed in the month of September.

The Brazilian Submarine Telegraph Company's Cable, between St. Vincent, Cape de Verds, and Pernambuco, Brazil, which was broken in September, in the neighbourhood of the Equator, in a depth of 1,900 fathoms, has been repaired, a length of about 80 miles of new cable having been spliced in. This cable had been immersed for a period of nearly 10 years.

A length of 800 miles of cable has been manufactured for the Eastern Extension Telegraph Company, to connect Saigon, in Cochin China, with Tongking.

A length of 847 miles of cable has been manufactured for the Eastern Extension Telegraph Company, for the renewal of certain portions of their lines in the China Sea, and between Java and Australia; and for the replacing of the Sunda Strait Cable, destroyed by the volcanic eruption of August, 1883. One of the company's ships is now employed on this work.

Various short lengths of cable have been manufactured for other companies during the year.

A contract was entered into with the Brazilian Submarine Telegraph Company in the month of October, 1883, for the duplication of their lines between Madeira, St. Vincent, and Pernambuco; and the manufacture of the cables is in progress.

The company's debentures have been renewed on the same terms, for a period of 5 years from the 1st January, 1884.

The factories at Wharf Road and East Greenwich, and the company's steamships, are in efficient working order. The *Calabria* made three voyages to Egypt on Government charter during the early part of the year.

The retiring directors are Sir Daniel Gooch and Sir Thomas Fairbairn, who, being eligible, offer themselves for re-election.

Swan United Electric Light Company, Limited.

AN extraordinary meeting of this company was held at the offices on Friday, the 15th inst., General Trevor presiding.

The Chairman moved a resolution confirming that passed at the meeting on the 29th ult., approving of the company's Bill in Parliament. He stated that after the amalgamation of the Edison and the Swan Electric Light Companies, it was thought some difficulties might arise as to whether the United Company would carry out the Provisional Orders which had been granted to the two companies. To obviate anything of that nature, it had been thought advisable to apply to Parliament for a Bill; but he was very glad to say now that these difficulties were practically removed, and they hoped to be able to carry out their object without the expensive process of an Act of Parliament.

Mr. Batt seconded the motion.

The Chairman, in answer to questions, stated that all the business was now transferred to the Edison and Swan United Company, who were selling the lamps very fairly well, and at a profit. This company had not done much to bring the electric light into disrepute, and therefore he could not account for the low price of their shares; but probably it was owing to the bad odour into which nearly all electric light companies had fallen. Besides that, it was still a matter of speculation as to what the future of the electric light was to be.

The resolution was carried.

National Telephone Company, Limited.

AN extraordinary general meeting of the shareholders in this company was held at the offices, 11, Queen Victoria Street, on Wednesday. Colonel R. R. Jackson presided.

On the motion of the Chairman, seconded by Mr. William Garnett, a resolution was passed authorising the directors to borrow the sum of £75,000 for the purposes of the company, and to secure the same by the issue of mortgage debenture bonds on such terms and conditions as the directors might think fit.

Faure Electric Accumulator Company, Limited.—Mr. S. Philippart, the chairman of this company, announces that a bankruptcy petition having been filed against him in the French tribunals, as to which he is now making legal appeal, the board of directors of that company has resolved that it is desirable to postpone the general meeting of the shareholders until such time as the tribunals shall have given their decision; this should result in about five or six weeks.

Great Northern Telegraph Company.—A cable has been laid by this company connecting the Island of Kiushiu (Nagasaki) with Tsusima and Fusan (Corea). The rate to Tsusima and Fusan, which stations were opened on the 15th inst., is, from all stations in the United Kingdom, 10s. 11d. per word.

C. G. E. Terraneau.—A meeting of the creditors of this bankrupt is summoned to be held at the Court, 34, Lincoln's Inn Fields, on March 5th, at noon; and the bankrupt is ordered to attend for examination.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotations, Feb. 20.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	8	1⅛ - 1⅜	1⅛
		Do. Do.	10	3¾ - 4	
30,000	5	Australasian E. L., Power & Storage Co.	3½	..	
24,900	10	British Insulite Co., Ld., "A" Shares	5	..	
30,000	5	Brush Elec. Lt. & Power Co. (Scotland)	2½	..	
25,000	5	Gt. Western Electric Light & Power Co.	2½	⅛ - ¼	
24,980	5	Hammond Elec. Lt. & Power Sply. Co.	5	1⅛ - 1⅜	1⅛
40,000	5	Indian & Ori. Electl. Storage Wks. Co.	2	..	
250,000	1	Maxim-Weston Elec. Lt. & Power Co.	1	⅛ - ¼	
100,000	5	Metrop. Brush Electric Lt. & Power Co.	3	..	
40,000	5	Pilsen-Joel & Gen. Elec. Lt. Co.	2½	..	
20,000	5	S. African Brush Elec. Lt. & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Ld.	2½	⅛ - ¼	
		TELEGRAPHS.			
1,892,480*l.*	Stk.	Anglo-American, Limited	100	37½ - 38½	37⅛
2,553,760*l.*	Stk.	Do. Pref. } Del. receiving no div. until	100	66 - 67	67.6⅛
2,553,760*l.*	Stk.	Do. Def. } 6 p. c. paid to Pref.	100	91 - 10½	
130,000	10	Brazilian Submarine, Limited	10	9⅛ - 9⅜	9⅛. ⅛. ⅛
16,000	10	Cuba, Limited	10	10¼ - 10⅜	10⅜
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	4⅛ - 4⅜	
6,000	10	Do. 10 per cent. Preference	10	15 - 16	
65,000	20	Direct United States Cable, Ld., 1877	20	10¼ - 10⅜	
100,000*l.*	100	Do. 6 per cent. Deb., repayable 1884	100	100 -103	
380,000	10	Eastern, Limited	10	10⅛ - 11	10⅛⅜
70,000	10	Do. 6 per cent. Preference	10	13 - 13⅛	13⅛. ⅛. ⅜
232,000*l.*	100	Do. 8 do. Debs., repayable Oct. 1883	100	..	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	100 -103	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	102 -106	
250,000	10	Eastern Exten., Australasia & China, L.	10	11 - 11⅛	11⅛
320,000*l.*	100	Do. 6 p. c. Debs., repayable Feb. 1891	100	107 - 110	
500,000*l.*	100	Do. 5 p. c. (Aus. Gov. Sub.) Deb. 1900	100	102 - 105	
140,000*l.*	100	Do. do. reg., repayable 1900.	100	102 - 105	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 - 105	
550,000*l.*	100	{ Eastern & South African, Ld., 5 p. c. } { Mort. Deb. Rg. redeemable } Jan. 1900	100	102 - 105	
	100	Do. do. do. To Bearer	100	102 -105	
22,050	10	German Union Telegraph & Trust, Ld.	10	10 - 10⅛	10⅛
250,000	10	Globe Telegraph & Trust, Ld.	10	6⅛ - 6⅜	6⅛. ⅛
250,000	10	Do. 6 per cent. Preference	10	12⅛ - 12⅜	12⅛. ⅛. ⅛
150,000	10	Great Northern	10	13⅛ - 13⅜	13⅛
100,000*l.*	100	Do. 5 per cent. Debentures	100	101 -104	
300,000*l.*	100	Do. 5 per cent. Debentures	100	103 -106	
81,200	10	India-Rubber, Gutta-Percha, & Tel. Wks.	10	22 - 23	22⅛. ⅛. 3. 2⅛. 3
100,000	100	Do. 6 per cent. Debs., 1886	100	102 -105	
18,000	25	Indo-European, Limited	25	30½ - 31½	31. 30½
40,000	10	London Platino-Brazilian, Limited	10	3⅛ - 3⅜	3⅛
12,000	10	Mediterranean Extension, Limited	10	1⅛ - 1⅜	
3,200	10	Do. 8 per cent. Preference	10	3 - 4	
10,000	8	Reuter's, Limited	8	9 - 9½	
358,225*l.*	Stk.	Submarine	100	195 -205	
75,000	1	Do. Scrip	1	1⅛ - 2⅛	1
4,200	Cert.	Submarine Cables Trust	100	97 -100	
37,350	12	Telegraph Construction and Mainten.	12	34½ - 35½	35⅛
150,000	100	Do. 6 per cent. Bonds, 1884	100	..	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1⅛ - 1⅜	
30,000	10	West Coast of America, Limited	10	5⅞ - 6⅛	
150,000*l.*	100	Do. 8 per cent. Debs.	100	107 -110	
45,791	15	Western and Brazilian, Limited	15	5⅜ - 5⅝	5⅜
24,119	7½	Do. Preferred	7½	6⅛ - 6⅜	
24,119	7½	Do. Deferred	7½	1⅛ - 1⅜	
200,000*l.*	100	Do. 6 p. c. Debs. "A" 1910	100	103 -106	
250,000*l.*	100	Do. 6 p. c. Mort. Deb. B. '80, red. Feb. 1910	100	98 -101	
1,500	$1,000	Western Union 7 p. c. 1 Mort. (Bg.) Bds.	$1,000	122 -126	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	103 -107	
88,321	10	West India and Panama, Limited	10	⅛ - 1⅛	1
34,563	10	Do. 6 per cent. 1st Preference	10	7 - 7⅛	7
4,069	10	Do. 6 do. 2nd do.	10	5 - 5⅛	
		TELEPHONES.			
224,850	1	Con. Tele. & Mainten., L., Nos. to 154,165	1	⅛ - ¼	
225,000	1	Oriental Tele. Co., Nos. 80,001 to 300,000	¼	⅛ - ¼	
100,000	5	United Telephone Co.	5	7⅛ - 7⅛	7⅛
20,000	5	Do. New, issued 2 p.m.	2	..	

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 15th, were £2,429, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended 15th February, amounted to £3,152.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held on Feb. 14th, Professor W. G. ADAMS, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members read, the Secretary announced the donations to the library, and referred to the decease of Mr. F. I. Scudamore, past president of the society.

A paper on "Some New Instruments for Indicating Current and Electromotive Force," by Messrs. R. E. CROMPTON and GISBERT KAPP, was then read.

Mr. CROMPTON first pointed out that the rapid development of the work of the electrical engineer rendered the use of instruments for making accurate measurements very necessary. Mr. Shoolbred, in his recent paper had described what had hitherto been done in the subject. The use of the word "meter" he considered objectionable, as properly speaking the term ought only to be applied to "integrators." "Indicator" was, he thought, a more suitable word. The object the authors had in view was the construction of instruments which would not alter their constants by lapse of time, so that the scale could be divided at once into ampères or volts. The graduation would, in the first instance, be effected by comparison with standard units, or by the chemical method; the latter, although very accurate, required considerable time. The use of springs or permanent magnets was objectionable, as they were decidedly liable to variation. Ducretet had suggested the employment of permanent magnets excited by a definite current occasionally, or soft iron magnets, excited at the time they were to be used. The authors adopted the latter method in a peculiar way, viz., they took advantage of the fact that a small mass of iron could only be magnetised to a certain degree of saturation, and that any current beyond the amount required to effect this produced no increased result. This saturated magnet was excited by the current to be measured, whilst the same current deflected a needle magnetised by the saturated magnet, and caused it to deflect in proportion to the strength of the current. The magnet was formed of two very thin charcoal iron wires coiled with copper wire. It was found that the magnetic effect on these iron wires was practically the same for 10 as for 100 ampères of current. The direct effect of the copper wire coils could be eliminated by placing the magnetised needle at right angles to the coils. He pointed out that the adoption of the principle actually enabled him to effect a *decrease* in magnetic effect by an *increase* in the current. The magnetised needle was arranged to fit closely in a tube, so as to render its movements dead-beat as far as possible. The arrangement of the instruments was such that if the current was sent the wrong way the indicating needle would make a half-revolution round the dial, and would move off the scale. 3 to 300 volts could be accurately measured.

In the discussion which followed the reading of the paper,

Dr. HOPKINSON stated that he had found Sir William Thomson's graded instruments very reliable.

Professor AYRTON thought that Mr. Crompton's objection to the use of the word "meter" was an unreasonable one, as the term was used in the "thermometer" and "barometer." He thought that springs could be made permanent in their elasticity. This was practically the case in chronometers. He also thought that permanent magnets, if treated with ordinary care, would also remain constant. Professor Ayrton then described his new form of meters, in which a spiral spring of flat steel was used. By pulling this spring a pointer fixed intermediate between the two ends would rotate. This property was made use of by attaching a piece of iron at the end, which was sucked into a solenoid; by this arrangement a large movement of a pointer could be obtained, the angular movement being directly proportional to the current passing through the solenoid.

Professor SILVANUS THOMPSON said he had experimented on the constancy of springs, and stated that Mr. Froude considered that they could be made quite permanent unless they were overstrained.

Professor HUGHES said that a permanent magnet, when magnetised, gradually became weaker. He thought that if a permanent magnet was continually hammered and jarred it would lose its magnetism down to a certain point, and would then remain steady.

Professor ADAMS and Mr. CROMPTON stated that their experience of Sir William Thomson's graded instruments was that they were not permanent except for certain periods.

The meeting then adjourned.

NEW PATENTS—1884.

3176. "Brush for conducting and imparting electricity to the human or animal frame." W. TAPP. Dated February 13.

3210. "Electric arc lamps." H. W. PENDRED. Dated February 13. (*Complete.*)

3222. "Electrical current measurer." H. F. JOEL. Dated February 13.

3249. "Preparation of selenium for, and the manfacture of selenium cells for electrical purposes, and apparatus therefor." W. R. LAKE. (Communicated by C. E. Tritts and D. H. Hopkinson.) Dated February 13. (*Complete.*)

3256. "Switches or circuit closers for electrical conducting apparatus." J. H. HOLMES. Dated February 14th.

3282. "Mechanical generation of electricity, also applicable for electro-mechanical purposes." E. L. VOICE. Dated February 14.

3295. "Holders for electric incandescent lamps." S. J. MACKIE. Dated February 14.

3308. "Insulated swivel coupling for the prevention of kinking in submarine telegraph cables, and which may be used for other similar purposes. J. S. HEPBURN, G. SOUTER. Dated February 14.

3318. "Means or appliances for the laying down and insulation of electrical conductors for the purpose of distributing electricity. C. E. WEBBER, Sir F. BOLTON. Dated February 14.

3322. "Reversing gear for electric motors, applicable for driving cars and other purposes, also grips for electric cars." A. M. CLARK. (Communicated by J. C. Henderson.) Dated February 14.

3340. "Magnets and magnetic garments or clothing for the prevention, relief, and cure of disease or other complaints of the human body; also applicable to the bodies of animals. G. CARRON. Dated February 15.

3369. "Locomotives or electro-motor engines for electric railways." F. H. DANCHELL. Dated February 15.

3387. "Telephone systems, and apparatus to be used therein." I. JOSEPH. (Communicated by R. M. HUNTER.) Dated February 15.

3397. "Sewing machines, and electrical devices for working same." W. P. THOMPSON. (Communicated by H. E. VIGNERON.) Dated February 16.

3416. "Machine for covering electrical conductors with insulating materials." A. MUIRHEAD, D. PHILLIPS. Dated February 16.

3436. "Telegraphic apparatus." J. GRAHAM. Dated February 16.

3462. "Commutators of dynamo or magneto-electric machines and electro-motors. W. A. CARLYLE. Dated February 18.

3473. "Electrical self-adjusting pendulum indicators." F. KING, W. P. MENDHAM. Dated February 18.

3527. "Production of electric light." R. H. GOULD. Dated February 18.

3530. "Manufacture of globes or envelopes for electric incandescence lamps." A. M. CLARK. (Communicated by C. de Changy.) Dated February 18.

3548. "Apparatus for utilizing atmospheric electricity." E. A. WILLIAMS. Dated February 19.

3551. "Electric telephones." A. A. CAMPBELL-SWINTON. Dated February 19.

3560. "Transmission of electric currents by submarine cables." F. BOSSHARDT. (Communicated by Herniette and Payroulou.) Dated February 19.

3570. "Dynamo-electric machines." J. H. GREENHILL. Dated February 19.

3571. "Dynamo-electric machines." J. H. GREENHILL. Dated February 19.

3579. "Process or method of casting plates for use as elements in secondary batteries, and apparatus to be used therefor or in connection therewith." H. J. HADDAN. (Communicated by C. F. Brush.) Dated February 19.

CORRESPONDENCE.

Electric Light Tests.

Referring to the account of the "Electric Light Tests at Louisville," given on page 63 of your number of January 26th, 1884, I desire, in justice to the system which bears my name, and for your readers' information, to make the following statements, which I believe are to the point.

In arc lighting, the relative photometric intensities to power expended are always greater the larger the amount of energy represented by an arc. The photometric yield will be considerably greater if 10-H.P. be expended upon five arc lights, than if ten smaller lights were produced. In the tests stated, where, as in the Jenney system 26·92-H.P. produced but sixteen lights, we should naturally expect a *considerably higher* photometric yield per horse-power, than where, as in the Thomson-Houston, 11·79-H.P. produced twelve lights. The difference found was but 5½ per cent. This certainly shows that the Thomson-Houston system obtained a *far superior* sub-division at *barely any* excess of expenditure.

Tests of arc lights where only *horizontal measurements* by photometer are made, are of no value in the present state of the art, for every electric light engineer knows that a *short hissing arc*, semi-incandescent

in character, gives a relatively higher horizontal measurement than does an *open*, *quiet*, and perfectly developed arc, while the downward light of the latter is relatively far greater than with the short arc.

The lights of the Jenney system are, as reported to me, of the short arc variety; while those of the Thomson-Houston system are quiet, open arcs, where the crater is fully exposed to permit downward radiation. The "tests" leave the results to be obtained by *spherical* measurement to be guessed.

Add to these facts the possession, by the Thomson-Houston system, of a thoroughly reliable automatic regulator, maintaining, despite speed variations and number of lights on circuit, and with an economy of power as lights are extinguished, a line current strength which does not vary over a fraction of an ampère, while in the Jenney no such appliances were present; the relatively greater cost of distribution of the heavy currents of the latter system; the lack of absolute accuracy of indicator card measurements, and of photometric measures, where the colour of light is not allowed for, the "tests" of arc lamps are, to say the least, very incomplete.

While not adopting the figures of the tests, we are tempted to be amused at the concluding sentence of the report, which, as more tersely expressed to us upon a recent occasion, was: "The Jenney system has the best 'cause,' while the Thomson-Houston has the best 'effect.'"

Elihu Thomson.

Lynn, Mass., *February 7th*, 1884.

[We have much pleasure in inserting Professor Thomson's communication, and doubtless the observations contained therein will be fully appreciated by electric light engineers.—EDS. ELEC. REV.]

The First Inventor of the Telephone.

"Another Richmond in the field."

The claims to have been the first inventor follow each other so fast, that scarcely is the ink dry which has announced a *first* inventor ere another first inventor's claims are announced.

In the REVIEW of January 7th, 1882, I announced the claim of Manzetti, of Aorto, Italy, to have invented a telephone in 1865; and on 28th same month I announced the claim of McDonough, and a description and drawings of his patent dated April 10th, 1876, were published. I now announce the claim of Meucci, an Italian, residing in New York, to have invented and constructed a telephone in 1849. I had heard rumours of such an invention, and treated it as a rumour; but it seems that there is more foundation for the rumour, as Meucci filed a caveat for his invention in the United States Patent Office in 1871.

The enclosed extract from a Baltimore paper shews that there is something more than rumour in this last claimant.

"A certificate of incorporation of the Globe Telephone Company of Baltimore City has been filed for record in the office of the clerk of the superior court. The incorporations named in the certificate are Robert Garrett, William Keyser, James Sloan, jun., William L. Scott, of Erie; Charles D. Fisher, Albert Porncoast, Alan P. Smith, James McHenry, of London; D. H. Bates, John H. B. Latrobe, and Howard Munnikhuysen. The names of capitalists, well known in the financial world, will be recognized in this list, and upon inquiry, it is ascertained that the operations, of which the incorporation of the Baltimore company is the beginning, are to be almost world wide. The Globe Telephone Company of New York, of which the local company is the first branch to be established, is the owner of the telephone patents known as Shaw patents, and also control the claims of Antonio Meucci, of New York, who, it is claimed, is the original inventor of the art of transmitting the human voice over wires by means of electricity. This claim rests upon no mere assertion of the claimant, but his assignees are in possession of the most abundant and indisputable evidences of the truth of the claim, and also of evidence of the most satisfactory character going to explain the matter of delay in the assertion of the right to a patent for the invention. The evidence above referred to consists of affidavits of many and disinterested parties, who either assisted at or witnessed the Meucci experiments, beginning as early as 1849 and running down to 1875, and who saw, handled, and tested his apparatus."

The following is a list of claimants to the honour of being the first inventor of the telephone, in order of the dates of their invention:—

1. Antonio Meucci 1849
2. Charles Bourseul 1857
3. Philip Reis 1861
4. Manzetti 1865
5. Daniel Drawbaugh 1866
6. James McDonough, April 4th 1876
7. A. G. Bell, Dec. 6th 1876

I hope to be able to send you more particulars in regard to this last claimant, Meucci, to have been the *very first* inventor.

W. C. Barney.

February 20th, 1884.

The Telephone.

I am obliged to you for the complimentary way in which you refer to my labours in connection with the history of the electric telegraph.

Your revelations regarding Daniel Drawbaugh are indeed startling, and prove once more the truth of the adage—that there is nothing new under the sun.

As a small contribution to the history of the telephone, I may be allowed to quote a passage from the Davy M.SS. No. 6, which, as I understand it, refers to some kind of telephone or telephonic relay. The passage is as follows:—

"The plan proposed, of propagating communications by the conjoint agency of sound and electricity—the original sound producing vibrations which cause sympathetic vibrations in a unison-sounding apparatus at a distance, this last vibration causing a renewing wire to dip and magnetise soft iron so as to repeat the sound and so on in unlimited succession."

The sheet from which I copy these remarkable words is headed "Exclusive Claims," and seems to have served as an *aide memoire* to the drawing up of some statement. It was written very early in 1838.

By "causing a renewing wire to dip and magnetise soft iron" Davy meant closing a relay in the circuit of which was an electro-magnetic sounding apparatus.

J. J. Fahie.

Paris, *Feb. 18th*, 1884.

The Invention of the Telephone.

The following sentence, which occurs in your leader ("The Telephone") in the REVIEW of 16th inst., has filled me with amazement:—"Notwithstanding that appearances may be against it, we venture to believe that Bell, although clearly forestalled in his long and arduous labours, was not aware of what had been previously accomplished, and that he is, therefore, truly an inventor, and not a mere adapter." It would seem that you had quaffed lately, and largely too, of the waters of Lethe, otherwise, how is it possible that you could have even ventured to express the belief, "that Bell was not aware of what had been previously accomplished." I take leave to state a fact, which to my knowledge, was well known by you, which your potations of Lethe's waters, perhaps, have effaced from the tablets of your (*editorial*) memory, and hence I am willing to accept your plea of "non mi recordo."

Has the fact not been published on several occasions in the REVIEW, "That Bell delivered, before the Society of Telegraph Engineers in 1877, a lecture, in which he gave a history of his researches in telephony?" and has it not also been stated in the REVIEW that that lecture by Bell was published in the *Journal of the Society of Telegraph Engineers*, and that Bell in that lecture said he had read several descriptions of Reis' instruments?—

1. By "Legat" in *Brix Zeitschrift, &c., &c.*, 1862.
2. In *Dingler's Polytechnisches Journal*, 1863.
3. In *Böttger's Polytechnisches Notizblatt*, 1863.
4. In *Kuhn's Handbook, &c., &c.*, 1866.

You, Messrs. Editors, *now* cannot plead ignorance of the fact that you knew that Bell had consulted the above-named authors, and that Bell "was aware of what had been previously accomplished," and hence-

forth a plea of "non mi recordo" cannot be accepted from you. By reference to the above-named authors, referred to by Bell, it will be seen what Bell learned from those authors, as to what "*had been previously accomplished*," and the means used therefor.

You cannot fail to be convinced that the belief, you mentioned that Bell was not aware of what had been previously accomplished, has no foundation whatever, and that you can plead *forgetfulness only* of what you certainly had prior knowledge, for having made your venture.

Thus far, it is proved from Bell's own words, that he "was aware of what had been previously accomplished," at all events, so much as was described by the authors referred to by him; and as to "the belief you venture that Bell was not aware of what had been previously accomplished," you can plead "non mi recordo." What did Bell learn from those authors?

In "*Legat*" Bell found descriptions and drawings of Reis' instruments, viz.: the conical tube transmitter and "the electro-magneto receiver with a lever armature." These instruments have been so often described in the REVIEW, and in other publications, that it is unnecessary to describe them here. I, however, make a few extracts from the letterpress of Legat. "By *speaking* into the tube, in consequence of the condensation and rarefaction of the air present in this tube, there will be evolved a motion of the membrane closing the tube at its lower end, corresponding to this condensation or rarefaction."

"In consequence of this process the electro-magneto receiver will be demagnetised and magnetised corresponding with the condensations and rarefactions of the mass of air in the conical tube, and the armature belonging to the magnets will be set into vibrations similar to those of the membrane in the transmitting apparatus."

"By this instrument in the practical investigations heretofore carried on, chords, melodies, &c., were transmitted with marvellous fidelity; while single sounds uttered as in reading, speaking, and the like, were perceptible more indistinctly. Nevertheless, here, also, the inflexions of the voice, the undulations of interrogation, exclamation, wonder, command, &c., attained distinct expression."

In *Dingler's Polytechnisches Journal* of 1863 and in *Böttger's Polytechnisches Notizblatt* of 1863, appear a description and drawing of Reis' square box transmitter and needle receiver. In the letter-press is to be found the following sentence: "The experimenters with these instruments could even communicate words to one another."

Von Carl Kuhn in his "Handbook on Applied Electricity," describes conical tube transmitter and magnet lever armature receiver, and says, "As regards the effectiveness of this apparatus, that while the similar number of the produced vibrations is reproduced by the receiver, their original strength has not yet been obtained by it. For this reason, also, small differences of vibration are difficult to hear, and during the practical experiments hitherto made, chords, melodies, &c., could be, it is true, transmitted with astonishing fidelity, while single words in reading and speaking were less distinctly perceived."

Can it be claimed that Bell, who admits that he had all publications before him, is "truly an inventor and not a mere adapter?" I respectfully maintain that, according to Bell's own confession, he is not *an* inventor of a speaking telephone (I use the word *an* and not *the*), but that he can be considered only as "a mere adapter" or improver of the Reis instruments.

I now put it to you, Messrs. Editors, will you, now that your memory has been freshened, admit that the belief you ventured to express, "that Bell was not aware of what had previously been accomplished," is without any foundation whatever, and, consequently, that your conclusion based upon that erroneous belief, viz., that Bell "is truly an inventor and not a mere adapter," is also without foundation.

W. C. Barney.

Feb. 18*th*, 1884.

Bell's Telephone Patents in England.

Permit me to make a few observations on the subject of Mr. Barney's letter, which appears, under the above heading, in your last week's issue.

It was not the case until recently, as Mr. Barney implies, that under no circumstances could the avoidance of a foreign patent affect the validity of a patent granted in Great Britain for the same invention. Section 25 of the Patent Law Amendment Act of 1852 enacts that where letters patent are granted in the United Kingdom for or in respect of any invention for which a patent has been obtained in a foreign country *before* the grant of such letters patent in the United Kingdom, all rights and privileges under such letters patent shall cease and be void immediately after the expiration *or other determination* of the term during which the patent obtained in such foreign country shall continue in force. The Patent Law Amendment Act of 1852 was, however, repealed by the new Patent Act which came into force on the 1st January of this year, and the said 25th section of the old Act has not been re-enacted. It follows, therefore, that the annulment after the 1st January of this year of any foreign patent anterior in date to a British patent for the same invention will *not* affect the validity of such British patent.

I also wish to point out that the patent law in the United States of America widely differs from our own in one important respect. In the United States the first inventor is alone entitled to a patent. If, therefore, any number of years after the grant of a patent, the most obscure individual brings forward a drawing, sketch, or model of the invention, made prior to the date of such patent, or prior to the date of the inception of the invention by the patentee, which drawing, sketch or model has been secreted during the whole of the intervening period, and supports his claim by the evidence of credible witnesses, he is adjudged the inventor, and the patent previously granted is invalidated. According to our own law, however, the first importer of a new invention, or the inventor who first obtains a patent for it, is the true inventor, and entitled to such patent. It avails nothing, therefore, that a man may have previously made a telephone like Bell's or Edison's, kept it secret in his shop or laboratory, and merely shown it confidentially to his own private friends. *That* does not constitute him an inventor in the eyes of the British law. The first inventor is the man who first makes the invention known to the British public, and not he who keeps the invention to himself, and when another person (equally an inventor) obtains a patent for it, brings forward his own prior secret usor. *This* will not invalidate the patent thus obtained.

I beg to add that I am neither retained by the United Telephone Company, nor by any other large owners of telephone patents; and therefore, in making the foregoing remarks, I am only prompted by a desire to place the facts of the case fairly and impartially before the public.

Thos. J. Handford.

42, Southampton Buildings,
Feb. 16*th*.

Drawbaugh's Magneto Telephone.

From the affidavits made in the action of Bell *v.* Drawbaugh, now pending in the U.S. court in New York, I make the following quotations:—

One witness testified that "he heard conversations through them carried on by Drawbaugh and himself, and that he both listened and talked at the instrument, using the same instrument to listen at and talk into."

Another witness testified, "that you could talk through either of them and hear through the same machine, using it both as a transmitter and receiver, and could hear and understand distinctly what was said through them."

And others testified, "that you could put one to

your mouth to talk and the other to your ear to listen at the same time," and "that it was used both as a transmitter and receiver."

This instrument was made in 1870, and produced in court; and Mr. Frank L. Pope, a well-known electrician, a witness for Bell, testified that "Drawbaugh's magneto machines were good practical telephones, capable of use for business purposes, and that No. 5 was as good an articulating telephone as he had ever heard.

W. C. B.

Feb. 19*th*, 1884.

The Action of the Telephone.

Your correspondent Mr. Strangways, in his letter of the 12th, which appears in this week's REVIEW, gives it as his opinion that "under the laws of electricity, acoustics, and mechanical motion . . . . . an undulatory current as described by Bell, would not produce speech."

Might I ask what "laws of electricity, acoustics, and mechanical motion" lead him to this somewhat extraordinary conclusion? It would also be interesting to know what form of *coils* Mr. Strangways uses in his "spark arrester," and whether the *extra current* does not play an important part in the action of the same.

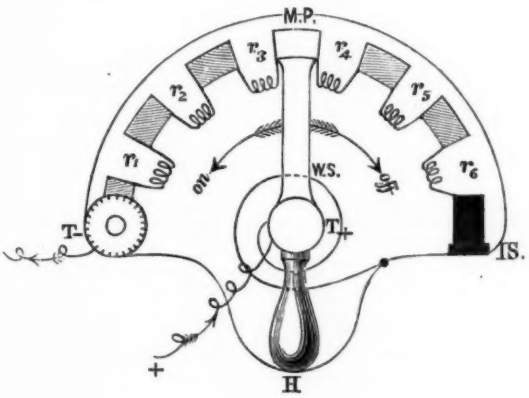
C. J. Cooke.

5, Elm Grove, Armley, Nr. Leeds,
Feb. 18*th*, 1884.

A Non-Sparking Key.

Referring to Professors Ayrton and Perry's non-sparking-key, illustrated by you in your to-day's paper, I would remark that more than a year ago I recognised the necessity for such an arrangement, and put into one of my specifications for the electric lighting of a steamship a clause to the effect that all the main switches should be constructed to gradually turn *on* and *off* the current by means of suitably-arranged resistances, so as to prevent sparking and shocking the lamps. I was led to do this by having seen the wood work of a large switch set on fire through suddenly turning off a strong current, and by having observed that at a particular installation a lamp which was placed in a position so that the workmen frequently amused themselves by turning it out and in, required to be more often renewed than those that were not interfered with.

I designed a switch to effect the purpose in view, and herewith send you a sketch. It seems to be the same in principle as the professors'.



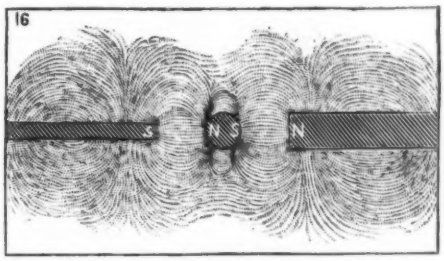
When the handle, H, is turned to the right, terminals, T + and T — are in metallic connection, with no resistance in circuit; but when turned to the left the resistances, r_1, r_2, r_3, &c., fixed below the baseboard, are gradually brought into circuit without sparking until the insulated stop, T, S, is reached, when the current is entirely cut off. On turning back the handle the current is put on, and the watch spring, W, S, prevents it being left in any intermediate position.

Andrew Jamieson.

College of Science and Arts, Glasgow.
February 16*th*, 1884.

The Theory of the Gramme Machine.

The audacity of Mr. W. M. Mordey is amazing. He asserts that the curves in my diagram "are exactly opposite to those obtained by Faraday."



The appended copy of one of Faraday's figures ("Experimental Researches," Vol. III., fig. 16, plate III.) will show that Mr. Mordey has been guilty of a gross perversion of facts, *as the curves shown are similar to those given in my diagram.*

I hope that it will be understood that I cannot discuss this subject further.

F. de Wolffers fils.

February 16*th*, 1884.

The Efficiency of the Heinrichs Dynamo-Electric Machine.

It is astonishing how far a headstrong person will commit himself when once in error or when his rash assertions have proved to be without foundation. Your correspondent "E." is an example of such a person who, for the purpose of sustaining his erroneous assertions, has been compelled to misrepresent the fact in dispute; which he would not have dared to do, had he not felt himself screened from personal responsibility by writing anonymously.

The practice of anonymously disputing facts and discrediting the attestations of eminent, known, and independent authorities, ought not to be encouraged. Earnest and impartial criticism produces beneficial results, and every earnestly given explanation of errors of scientific principles or calculation reflects credit upon the one who explains the error; thus the "explainer" need not screen his identity as an "informer."

To write anonymously, when explaining scientific principles, can only be claimed by a person with little experience (beginners), who must not be too persistent; or a person whose authoritative voice has met with many checks and whose motives have repeatedly been questioned; obviously, the assertions of such a party ought to be discredited and deservedly treated with contempt.

Unfortunately for me, the subject of "E.'s" letter is the efficiency of my dynamo-electric machine, and since I have once paid attention to "E.'s" assertions, I am compelled to ask once more your indulgence and space in your valuable journal, not for a reply to "E.," but to lay before you and your readers a short *resumé* of the facts of the controversy, showing plainly the inconsistency of "E.'s" assertions.

"E.," in his letter, ELECTRICAL REVIEW of the 2nd instant, made the following statements:—

That I had sought to express the *total* efficiency of my machine by the high number of watts produced per pounds of copper wire.

That, from the tests taken from *Engineering*, the efficiency of my machine, in regard to the current available for the external circuit, was 67 per cent., which he stated to be a low efficiency indeed.

That in that misleading article *it was further stated*, that the Heinrichs dynamo gives one light for each 5½ pounds of copper wire, instead of 10 pounds in the "Brush."

That the latter statement was a convenient way of looking at the out put of the machine (cheapness), but that the unfortunate individual (the buyer) would have to pay at the year's end for the horse-power expended in heating the wire of the dynamo.

In my very considerate reply, in ELECTRICAL REVIEW of the 9th instant, I answered "E.'s" assertions as follows :—

I had *never* quoted the high number of watts in proof of the *total* efficiency of my machine, but *only in proof* of the high efficiency of its principle of construction.

That the 67 per cent. of the total current available for external circuit, was an extraordinarily high efficiency for a machine of the small size or class, and I challenged "E." to name any other machine, which, other conditions being about equal, showed the same efficiency. I showed further that the efficiency of my machine, when supplying the usual current for arc light, was between 80 and 90 per cent. That the comparison of 5½ pounds of copper wire on my machine as against 10 pounds on the "Brush," was a modest one, since I was entitled to a far greater efficiency in that respect, having burned six lamps with that small machine.

That the buyer of my machine would not have to expend horse-power in heating excessively the wires of my machine, since I employed little copper wire having a low resistance. I further called upon "E." to apologise for the breach of privilege when stating that the article in your contemporary, *Engineering*, was misleading.

Having thus patiently proved to "E." the errors and inconsistency of his assertions, I felt certain that he would apologise, and the matter would have ended there ; but "E.," in his last letter, ELECTRICAL REVIEW of the 16th instant, "discards the questionable motives I was pleased to attribute to him," (which ?) and he proceeds to reply, *i.e.*, sophistically intermixing and twisting his assertions and distorting my considerate reply, he arrives at the following evasive and delusive arguments :—That he was bound to take the lowest set of figures from the tests, since, in the article referred to, it was distinctly stated that the Heinrichs dynamo gave one light for each 5½ pounds of copper wire against 10 pounds in the "Brush," and that such *one-sided* comparisons are highly misleading.

Here "E." argues like an ostrich who has buried his head over the ears in the sand of the desert, and thinks nobody can see him. As known, I challenged "E." to name a machine of the size and class as my own, which showed about the same efficiency. I stated distinctly that the 67 per cent. was a high efficiency for such a small machine. "E." has admitted in his first letter that larger machines give greater efficiency. Just so, my machine gives a still greater efficiency when specially constructed to supply large currents. Evidently, the buyer of one of my small machines will run the machine with a current which gives either the highest efficiency—88 per cent.—or suit his convenience and take a large current from the small machine and be satisfied with a lower efficiency, which is, notwithstanding, greater than in any other machine of the same size.

As known, I challenged "E." to apologise for his breach of privilege, but instead of apologising and withdrawing his rash assertions, has made matters worse when twisting his first assertion and saying that the *one-sided* comparison was highly misleading ; thus, he turns from one offensive assertion to another, and proves how far a headstrong man can commit himself, instead of apologising for his errors of tact and judgment.

"E." further stated in his last letter in your last issue : "that the fact of having burnt six lamps with my machine *does not modify his arguments one wit*," although on that particular occasion he *suspects* that the speed (of my machine) was nearer 1,800 revolutions than 800 ; and he then further shows that he can in fact calculate the number of watts from the figures taken by Mr. Kempe, thus proving that he has more than the ordinary smattering of an amateur, though from his conclusion that the speed of my machine was nearer 1,800 revolutions, I could see that he had only superficially entertained the whole subject, and that he was still in the chrysalis state. Had "E." looked quietly over the figures he particularly attacked he would have found that the speed of my machine need not materially be more than 880 revolutions per minute when I burn six lamps, each lamp requiring a current of 10 ampères and an E.M.F. of 40 volts ; nay, that I can burn nine lamps as well as six without altering the speed of the machine. It depends only on the lamps being properly connected up, which every beginner can do, and it does not require "an expert accustomed to base his calculations of the merits of the machine" for such a simple question.

The tests of a Gramme taken by "E.," and mentioned in his letter in your last issue, prove nothing, since no further particulars were given. Furthermore, statements made by an anonymous writer, who is personally irresponsible for his assertions, cannot well be credited with *that amount of sincerity* which excuses the errors of known writers.

"E." has after all followed a little of the advice I gave him in my last letter, and has not answered at once "to the more interesting part of my letter," relating to the action of the Gramme-Pacinotti ring, though he threatens to be ready probably in your next issue. I should have thought a little more time and more reflection would produce better results, and I advise "E." once more to study carefully the subject before he writes again, and then write as a man who "knows" and who "may be known," since I, for my part, shall not further pay the least attention to the arguments of an anonymous writer, professing to expound scientific principles.

Apologising for the great length of this controversy,

Charles F. Heinrichs.

London, *Feb. 18th*, 1884.

[With the insertion of Mr. Heinrichs' letter we think that the correspondence on the efficiency of that gentleman's machine should come to an end, as he has promised to be ready in a short time with a fresh set of tests. We shall, however, be pleased to hear our readers' explanations of the action of the Gramme ring. —EDS. ELEC. REV.]

Information Wanted.

I am making a small shunt-wound dynamo, and am perplexed how to proportion the resistance of the armature to the resistance of the field-magnets. I should be glad of any information on the subject. The armature is a sort of Gramme ring. Also, what iron should I make the magnets of ? Is the Iron known as the "Crown" brand suitable ?

Magnet.

4, Charles Street, St. James's Square.

In your issue dated March 17th, 1883, there are two examination questions, sent to you by Sir Wm. Thomson. The first is comparatively an easy one, but the second I am unable to solve, and I have never seen a similar example in any book on dynamics. I know that there are several constant readers of your paper who have often attempted the question but have not succeeded in obtaining a satisfactory solution.

So I venture to ask you to give in your paper a full and simple demonstration of the problem, and oblige

Ignoramus.

Wes. Trg. College, Westminster,
London, S.W.

[Perhaps others of our readers may find time to attempt the solution of the question to which our correspondent refers.—EDS. ELEC. REV.]